Attend the big convention of the Central Association of Science and and Mathematics Teachers in Indianapolis, November 26 and 27, 1948.

CONTENTS FOR NOVEMBER, 1948

SCHOOL SCIENCE AND MATHEMATICS

VOL. XLVIII | NOVEMBER, 1948 | WHOLE NO. 424

THE 1948 CONVENTION

History has on parade many benefits which have come to individuals and groups of individuals from the fruits of united thinking and planning at significant meetings. As great tribute to united planning we have among nations our own United States of America, in the field of science research the AAAS, and in organizations of teachers our own cherished CASMT. Our organization has stood for nearly half a century as tribute to the ideals of the founders, and to the meeting at which its foundations were laid. The hope of the founders has re-echoed annually for 48 years in our conventions and in our convention programs. Many generations of teachers in science and mathematics have derived from these meetings information, inspiration, leadership and countless hours of real joy and happiness.

The 1948 convention is planned to be a great sequel to preceding conventions. You have seen the program offerings; all is in readiness, speakers are even now preparing to come from widely scattered geographical areas. All we need is You to make the days perfect. Your presence will be a stimulation to the committees and to the speakers; you and the Association have need of those wonderful ties of friendship and fellowship which are formed at our annual meetings.

In true Hoosier hospitality we invite you to spend at least November 26 and 27, 1948 in Indianapolis and weave into your life the offerings of the 1948 convention program.

J. E. POTZGER, *President*,
Butler University,
Indianapolis, Indiana

AT THE CONVENTION

Hear the story of the Atlantic Ocean Basins told by Professor Ewing and Our Navy in the Antarctic by Captain Dufek.

See the new books, maps, charts and apparatus.

Visit your teacher friends from other schools.

THE ANNUAL CONVENTION AT INDIANAPOLIS

Local committees are busy completing plans for the annual convention of the Central Association of Science and Mathematics Teachers which will be held at the Claypool Hotel in Indianapolis, Indiana, on November 26 and 27 of this year.

The hospitality committee has arranged for hostesses to serve at the Information Table during the entire convention. They will be happy to give you information concerning the convention and the

INDIANA COMMITTEE CHAIRMEN CONFER WITH PRESIDENT POTZGER
Left to Right: Standing, Mr. Albert Mahin, Miss Vivian Ely, Miss Mona Jane Wilson, Mr. Virgil Heniser; Seated, Miss Miriam King, Mrs. Henrietta Parker, Dr. J. E. Potzger, and Mrs. Marie S. Wilcox.

city of Indianapolis. The annual banquet promises to be a gala affair and a special committeee is planning an informal social hour to follow the banquet. No general luncheon has been planned. The latest films for use in science and mathematics instruction will be shown during the entire noon recess in the Travertine Room on the lobby floor of the hotel.

If you have always wondered how the famous Indianapolis 500 mile race track looks to the driver of the race car, you will be given the

opportunity to see for yourself at the Indianapolis convention. On Saturday afternoon, you may have a choice of trips, either through the laboratories of the Indiana State Board of Health or those of the Bureau of Materials and Tests of the Indiana State Highway Commission. Following these trips, all cars will meet at the race track and be driven around the track (not at 125 miles an hour, however).

Members of your family who accompany you to convention but do not care to attend meetings, should ask at the Information Table concerning entertainment which has been planned for them.

The association Year Book contains the details of the outstanding program arranged for the convention by association officers. If you have not already received a Year Book, write to me and I will see that you get one. You can not afford to miss this Indianapolis convention!

Marie S. Wilcox,
General Chairman of Local Arrangements,
George Washington High School,
Indianapolis 22, Indiana

WHAT CAUSES RAIN?

Benjamin Bold
Boys High School, Brooklyn, New York

There is a common misconception that a cloud consists of water vapor, and that rain is the result of the condensation of the vapor. When the fact that water vapor is invisible is brought to the attention of an individual with such a belief, he immediately realizes the untenability of his hypothesis.

A cloud consists of minute, yet visible, water drops or ice crystals. Several hypotheses have been advanced to explain the mechanism causing rain: the most widely accepted one being based on the colloidal instability that results in a cloud consisting of a mixture of ice particles and subcooled water droplets. Bergeron's theory (as the above is called) has received striking confirmation in the recent experiments in releasing precipitation by dropping ice crystals in a cloud.

Bergeron's hypothesis is based on the fact that the saturation vapor pressure over ice (or snow) is lower than that over subcooled water. Consequently, air that is saturated with respect to water is supersaturated with respect to ice. In a cloud consisting of a mixture of water droplets and ice crystals, the vapor pressure of the air would be a compromise between the two saturation pressures. For instance, at $-10°C$, the relative humidity of air that is saturated over ice, is slightly more than 90%. If the vapor pressure is a compromise between the two saturation pressures, the water droplets would evaporate and condense on the ice particles. Thus the ice particles would increase in size.

The volume, and therefore the weight, of the ice crystals would vary as the cube of the radius (if we consider the crystal spherical in shape), but the surface area would increase only as the square of the radius ($S=4\pi r^2$). Therefore, the weight of the crystals would increase more rapidly than the upward force supporting the particles, and they would fall through the cloud. If the temperature near the surface of the earth is above freezing, the ice particles may melt before reaching the ground.

DIFFUSION DEMONSTRATIONS

JOSEPH A. MACK
McBride High School, St. Louis, 13, Mo.

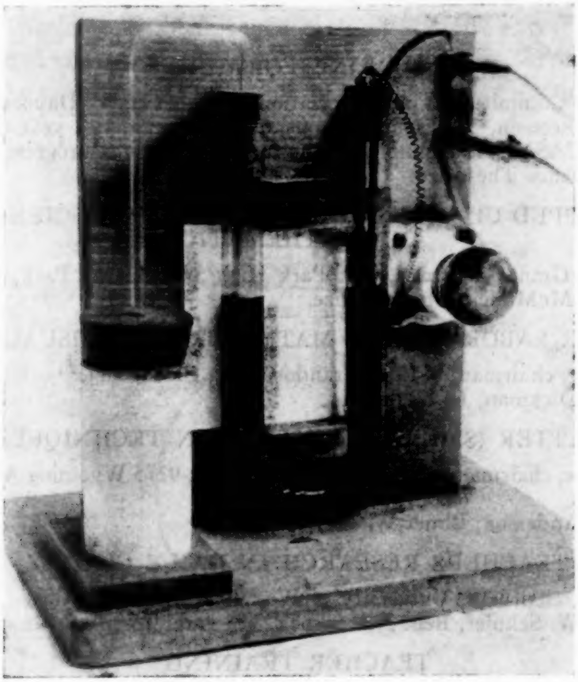
The Law of Effect and the Principle of Motivation enunciated in psychology are subscribed to without dissent by most teachers. Moreover, from their experience teachers know only too well the fugitive nature of interest and the consequent inattention. But once its nature is understood, interest might be secured with less expenditure of effort than when only random action is used. Interest is defined as the intellectual satisfaction consequent upon man's intellectual activities. In the classroom these activities can be controlled to a degree by the arousing of the student's curiosity. But comprehension cannot be so easily attained or controlled. How often have we not experienced the slowness of this mental process in our classes and heard: "Oh, that's what you mean!" only after several demonstrations or repeated presentations and that by different approaches. It is the writer's belief that several demonstrations of the same principle, each of short duration, each with a slight variation of the previous technique, are highly successful to secure comprehension in the student.

Diffusion of odors is a common enough experience to require but a passing mention of the fact. Not so easily imagined nor even believed by the student is the selective nature of the diffusion of gases through porous walls. The demonstration experiment most frequently illustrated in texts of both physics and chemistry is the accumulation of hydrogen or of illuminating gas in a bell jar or large beaker by the displacement of air. This collected gas is then transferred over the unglazed porcelain cup, which is stoppered and terminates in a glass tube that dips into colored water. The bubbles arising where the glass tube ends in a beaker of colored water is taken as evidence that diffusion has taken place. When the experiment is repeated with air in the bell jar or beaker that formerly contained hydrogen or illuminating gas, no pressure is produced and no bubbles are in evidence.

Now to convince the still doubting Thomas. He is usually brash and not easily embarassed. So call him to the table and ask him to blow against the porous cup. "Blow hard, blow harder!" But nothing happens. If a burning bunsen flame is now pinched out and the gas hose directed against the porcelain cup from as much as three inches distance, the evidence of bubbles cannot be laughed off by any claims to halitosis.

A more spectacular apparatus is the permanent piece where the flash of an electric light is employed, preferably red, as that color is

associated with the danger signal. The essential piece, the unglazed porcelain cup is the same. The diffusion pressure is transmitted through a connecting tube to a glass U-shaped (drying) tube which contains acidulated colored water as visible indicator of the pressure by the imbalance in its arms. If a white cardboard is mounted behind the U-tube the visibility will be increased. Into the second arm of the U-tube a two-hole rubber stopper containing two electrodes is inserted, and the electrodes connected in series with a 7½ w. lamp. This stopper is somewhat pared on its sides or channeled to allow the otherwise enclosed air to escape. The electrodes may be monel metal



or even copper wire, #12, B & S. The whole assembly can be permanently mounted on wood for ease of handling and facility of storage. Two binding posts allow for the rapid annual set up. When the laboratory supply of illuminating gas is directed toward the unglazed porcelain cup, or even if the hose lies within three inches of it and the gas is escaping, the diffusion pressure is sufficient to raise the acidulated water and make contact between the electrodes to light the lamp. The reaction time is usually less than a minute. The time for the diffusion of the gas to reverse into the room and the lamp to extinguish is about twice as long. The experiment can be repeated if necessary.

These three demonstrations are safe as compared with the diffusion of gas to air and of air to gas contained in two bottles, over and under each other, test being by ignition which at times approximates explosion. If this experiment seems desirable, it would be better to use hydrochloric acid vapor in one bottle and ammonia vapor in the other.

It is the writer's belief that while grey hairs may not be avoided by increasing the number of demonstrations, much useless fretting and worry could be avoided by demonstrating every principle and law by several demonstrations.

LOOKING FORWARD

The Policy Committee of our Association, of which Ira C. Davis of The University of Wisconsin, Madison, Wisconsin, is chairman, last year directed the attention of CASMT to planning for the future. Work is in progress on five important problems. These are:

STEPPED-UP HIGH SCHOOL PROGRAM IN SCIENCE AND MATHEMATICS

Charlotte L. Grant, chairman, Oak Park High School, Oak Park, Ill.
Harold G. McMullen, Elmer Kunze.

BETTER LABORATORIES, MATERIALS, AND VISUAL AIDS

Philip Tapley, chairman, 8110 S. Crandon Ave., Chicago 17
Joseph E. Dickman, D. L. Barr

BETTER (SIMPLER) EVALUATION TECHNIQUES

Helen Monroe, chairman, MacKenzie High School, 9275 Wyoming Ave., Detroit 4, Mich.
Sigfrid E. Anderson, Elmer W. McDaid

TEACHERS RESEARCH IN DAILY CLASSES

J. R. Mayor, chairman, University of Wisconsin, Madison, Wis.
Frederick W. Schuler, Ben. N. Peacock, Margaret Joseph, Milton Pella

TEACHER TRAINING

Ella Marth, chairman, Harris Teachers College, St. Louis, Mo.
C. A. Smith, Norman R. D. Jones

All of these are forward-looking projects in which the teaching profession is vitally interested. The committees are widely scattered to insure contact with trends of thought in different geographical locations.

The committees are busy at work to prepare plans, to make suggestions, to develop helpful techniques. A mimeographed preliminary report of this work will be distributed at the November Convention.

All of these problems could be more efficiently solved if our members would participate actively in the work of these committees by submitting suggestions, by sending material having bearing on the problems to the various chairmen, and by drawing attention to various phases on such problems in their locality. The committees welcome such membership participation. If you have something to contribute, write to the chairman of such committee.

J. E. Potzger, President

THE TAPEWORM AS A BIOLOGICAL EXAMPLE OF A MATHEMATICAL INVERSION

F. C. W. Olson
Ohio State University, Put-in Bay, Ohio

An inversion is a transformation of the type $R=a/r$, where R and r are radial distances in polar coordinates and a is a constant. This transformation is one of the favorites of mathematicians and physicists, particularly since it frequently simplifies the analysis of problems dealing with infinity. As r approaches infinity, R approaches zero. In effect, with an inversion, we can look at infinity at the origin —a most convenient place. Since mathematicians and physicists are apt to regard an inversion as their own, it may seem surprising to find a practical example of an inversion in the lowly tapeworm.

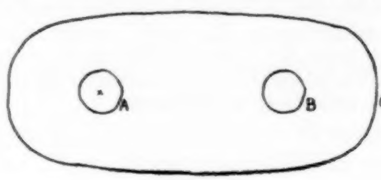


Fig. 1a

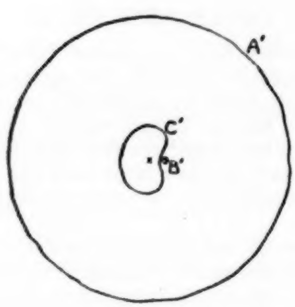


Fig. 1b

The pork tapeworm *Taenia solium*, according to Storer* has a length of 6 to 25 feet when mature. It has a minute head or scolex with a short neck joining the scolex to the main body which consists of a series, up to 1000 in number, of sections called proglottids. Since the tapeworm lives in the intestine of its host, it requires no stomach or intestine of its own. It merely "borrows" that of its host. The walls of the proglottids absorb the already digested food suppplied by the host. It is easy to see that the tapeworm is inverted biologically since its "innards" are on the outside.

The cross section of an idealized proglottid is shown in Figure 1a.

* Storer, Tracy I., *General Zoology*, McGraw-Hill, 1943 (New York).

Here A and B represent two excretory canals and C is the outer wall or absorbing membrane. If we now perform an inversion of Figure 1a with respect to a point inside one of the excretory canals, Figure 1b will result. The region outside of A' (corresponding to the region inside the excretory canal A) becomes the outside of the animal, and the "inverted intestine" C becomes C', which is inside—just where it should be in a normal animal. The other excretory canal B goes into B'.

This example, while interesting, obviously should not be carried too far nor taken too seriously. There are, however, certain features which may bear further investigation. For instance, is there anything in the comparative embryology of the platyhelminthes to suggest that the turbellaria and trematoda develop "normally" while the cestoda develop "inversions"?

EDITORIAL NOTE: This article is presented for possible comment, both by mathematicians and embryologists. The last sentence is particularly intriguing, since the development from the cyst into the mature worm suggests such an inversion, but whether histological study would bear this out should be answered by one well-versed in invertebrate embryology.

THREE NEW FILMS

Alaska—A Modern Frontier (One reel, sound, color or black-and-white; Collaborator: Thomas Frank Barton, Ph.D., Associate Professor of Geography, Indiana University) gives students an opportunity to travel through the wilderness for a first-hand view of Alaska. They'll see the thriving, modern community of Fairbanks. They'll take a trip with "the flyingest people in the world" to visit gold miners, salmon fishermen, pioneer farmers of the Matanuska Valley, Eskimos on the coast of the Bering Sea . . . to see for themselves why Alaska is really a modern frontier.

Let's Count (One reel, sound, color or black-and-white; Collaborator: F. Lynwood Wren, Professor of Mathematics, George Peabody College for Teachers) is a film which fills the gap between the haphazard counting of youngsters in the primary grades and their introduction to arithmetic. As primary students watch Sally and Joe, they see how useful counting can be. They learn the difference between ordinal and cardinal numbers and how easy it is to use tally marks and numerical symbols to answer the question "How Many?"

The Nature of Light (One reel, sound, color or black-and-white; Collaborator: Ira M. Freeman, Ph.D., Associate Professor of Physics, Rutgers University) takes students on a fishing trip with two boys who study light as a form of radiant energy, closely observe the principles of reflection and refraction, and learn how these principles are applied to the science of optics . . . the way in which all things in nature are affected by the nature of light. Physical Science students in junior and senior high will derive the greatest benefit from this new Coronet Film.

Each of these new Coronet Films is one reel in length and may be secured through Purchase or Lease-Purchase for $90 in full color or just $45 in black and white. Write to:

CORONET FILMS
Coronet Building
Chicago 1, Illinois

ELECTROMAGNETIC THEORY OF LIGHT FOR STUDENTS OF CHEMISTRY

George Antonoff and Robert J. Conan, Jr.
Fordham University, New York 58, N. Y.

Our views on the nature of light have been changing in the course of time. Newton was responsible for the corpuscular theory of light. Tiny rapid moving particles were supposed to be emitted by an incandescent body, which account for the visual effects observed by us. The fact that light produces a mechanical pressure, which is measurable experimentally, appears to be in favor of such a theory.

However, the corpuscular theory is not capable of giving any satisfactory explanation of the phenomenon of interference. For this and other reasons, it was superseded by a wave theory. Such a theory necessitates the hypothesis that space be filled with an "ether," an imponderable substance capable of penetrating all things. According to Huygens the phenomenon of light is due to the vibrations of particles of ether, which when set in motion transmit the wave. Fresnel showed that these vibrations might be transverse, i.e., the particles must vibrate at right angles to the direction of propagation of the wave.

Here the transmission of sound waves differs: for this consists of longitudinal vibrations, i.e., vibrations of particles of matter, such as air, in the direction of propagation. If the air is removed the sound wave is not propagated, because the medium, the carrier of the disturbance, is removed.

Since light is transmitted in the absence of air, or any other materially recognized substance, some other medium must be assumed to exist to account for its propagation. This is further justified by the fact that classical science does not recognize "action at a distance."

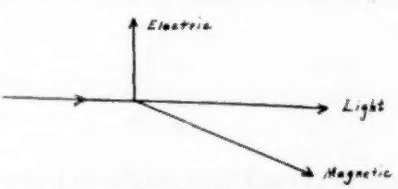


Fig. 1. The electrical and magnetic components of light.

The theory of light underwent an essential modification in the hands of Clerk Maxwell, a professor at Cambridge. He made a careful study of Faraday's experimental researches on electricity and magnetism, and was able to express the latter's findings in the language of mathematics, which took nearly a lifetime. And by purely

mathematical means he was led to the idea that light is a kind of electro-magnetic wave. According to him, light has electrical and magnetic components at right angles to each other, and at right angles to the direction of propagation.

The electrical and magnetic intensities are both pulsating, thus producing an electro-magnetic wave. Furthermore, according to this theory, the particles of ether vibrate in the plane coinciding with the direction of the magnetic component, but not all authors concede this. However, it is a minor point.

Maxwell believed that electromagnetic waves of various frequencies other than that of light could be produced in the laboratory, but he was unable to do this himself. However, his theory* paved the way to the discovery of the wireless, or radio wave, for the wave that he had predicted was actually obtained by Heinrich Hertz in the year 1888. Another consequence of Maxwell's studies was the idea that there must be separate magnetic poles capable of independent existence, which can act as carriers of a magnetic current in the same way that positive and negative ions may carry an electric current. In these predictions he was far ahead of his time; yet he died at 39 years of age.

In order to make the above clear, it is necessary to recall some laws of electricity and magnetism. The well-known Coulomb's Law is of the form

$$F = \pm \frac{1}{\kappa} \cdot \frac{e^2}{d^2}$$

which gives the force of attraction or repulsion F (according to the sign) between two unit electrical charges e, which are separated by a non-conductor to a distance d from each other. κ is known as the dielectric constant.

A similar expression for the force of magnetic attraction or repulsion may be given

$$F = \pm \frac{1}{\mu} \cdot \frac{m^2}{d^2}$$

where m is the strength of each unit magnetic pole, and d the distance between them; μ is a constant known as the magnetic permeability.

In these expressions the coefficients κ and μ are analogous in that they both depend upon the nature of the medium which separates the two poles or charges. The dielectric constant κ is taken as numerically equal to one for a vacuum, and is greater than one for all other

* Published in 1865.

media. This means that when charges are embedded in a non-conductor, the force of attraction is reduced according to the magnitude of κ for the given substance. The constant μ for a magnetic field plays the same role as does κ for the electric field, but there is a difference. Whereas κ is always more than one for all material media (and μ is equal to one for a vacuum), there are cases known where μ is less than one, for example, bismuth. Such substances are called diamagnetic. If μ is greater than one they are called paramagnetic, and if μ is very much greater than one, they are called ferromagnetic substances.

By means of Coulomb's law the value or e may be found

$$e=(\kappa Fd^2)^{1/2}$$

and the dimensional expression for e will be

$$[e]\equiv[\kappa^{1/2}M^{1/2}L^{3/2}T^{-1}]$$

(since force = mass times acceleration $\equiv MLT^{-2}$, and $d^2\equiv L^2$; the sign $\equiv$ means dimensional equivalence).

In view of the fact that a moving charge generates a magnetic field, the latter can also serve as a measure of e, and a dimensional expression for e may also be deduced from this consideration. The way it is obtained is somewhat complicated, so that merely the result will be given:

$$[e]\equiv[M^{1/2}L^{1/2}\mu^{-1/2}].$$

The two dimensional equations for e must be equivalent.

$$[M^{1/2}L^{1/2}\mu^{-1/2}]\equiv[M^{1/2}L^{3/2}T^{-1}\kappa^{1/2}]$$

rearranging and simplifying—

$$[\mu^{-1/2}\kappa^{-1/2}]\equiv[LT^{-1}].$$

This means that the term $1/\sqrt{\kappa\mu}$ has the dimension of velocity, since velocity is defined as distance traveled per unit time.

Let us imagine, together with Maxwell, a wave of vibrations traveling in a medium with a dielectric constant κ and a magnetic permeability μ. He uses an equation of motion of the form:

$$\nabla^2F=\mu\kappa\frac{\partial^2F}{\partial T^2}$$

where ∇^2 stands for the operation

$$\frac{\partial}{\partial x^2}+\frac{\partial}{\partial y^2}+\frac{\partial}{\partial z^2}.$$

In this expression F is an electrical force due to motion. The dimensions of the terms in this equation give us the relation:

$$[F][L^{-2}] \equiv [\mu\kappa][T^{-2}z[F]$$

here, $[F]$ drops out and we get

$$[\mu\kappa] \equiv [L^{-2}T^{2}] \quad \text{or}$$
$$[\mu^{-1/2}\kappa^{-1/2}] \equiv [LT^{-1}]$$

which shows once again that $1/\sqrt{\mu\kappa}$ is a velocity.

Imagine that we are dealing with a vacuum (or free ether) and let $1/\sqrt{\mu\kappa} = c$. Then the equation of motion becomes

$$c^2 \cdot \nabla^2 F = \frac{\partial^2 F}{\partial T^2} \cdot$$

By means of mathematics it can be shown that *all* possible solutions of this equation represent waves traveling with a velocity c. And thus c or $1/\sqrt{\mu\kappa}$ is the only velocity with which electromagnetic disturbances can be propagated through ether.

It was found by experiment that the term $1/\sqrt{\mu\kappa}$ for a vacuum had a value of 3×10^{10} cm/sec., which is exactly the observed velocity of light. From this fact Maxwell was able to conclude that light consists of electromagnetic waves. As a further consequence of his theory, he predicted that light falling on a material surface should produce a pressure on the surface, and such an effect was observed by later workers. This and other effects served to prove the correctness of his theory.

The applications of the fundamental theory are numerous.

Since both terms κ and μ from preceding equations were defined as being equal to one for a vacuum, it is seen that velocity of light in a vacuum is given by $c = (1/\sqrt{\kappa_0\mu_0}) = 1$ unit. For any other medium it follows by division that the velocity (c_1) is expressed by

$$c_1 = \frac{c}{\sqrt{\kappa\mu}}$$

where κ and μ are the physical constants for that medium.

When light passes from medium 1, say a vacuum for which $\kappa = 1$, into a medium 2 where κ is more than one, the ray is refracted. By definition the refractice index n is ratio of the sine of the angle of incidence to the sine of the angle of refraction:

$$n = \frac{\sin\theta}{\sin\theta_1}$$

and by definition it is also equal to the ratio of the velocities of light in the two media

$$n=\frac{c}{c_1}$$

or by substitution

$$n=\frac{c}{c/\sqrt{\kappa\mu}}=\sqrt{\kappa\mu}$$

which gives us an easy method for evaluating this quantity in a

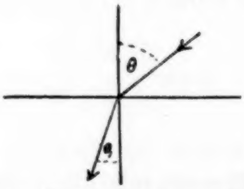


FIG. 2. The refraction of light.

given medium. Since the magnetic permeability of nearly all transparent media is close to unity, we may put $\mu=1$, and

$$n=\sqrt{\kappa}.$$

This relation has been shown by experimental comparison of both terms to be valid for all dielectrics (or insulators), if they are transparent and colorless. The constant κ may be obtained by discharging a condenser with the given medium between the plates, through a ballistics galvanometer.

If the medium is a conductor with a specific conductivity σ, the velocity of the propagation of the light wave will be

$$v=\sqrt{\frac{\nu}{2\pi\mu\sigma}}$$

if ν is the frequency of the incident beam. Thus a wave falling on a metal surface is rapidly destroyed as it penetrates a small distance into the metal, the energy being converted into heat. The velocity is not a constant, as in the case of ether or a dielectric, but depends upon the frequency of the light. And this phenomenon of distruction means that no appreciable light would get through a conductor unless it is in a very fine sheet, or in other words, all conductors should be opaque to light in proportion to their conductivity.

The refractive index of a metal should be

$$n=\frac{c}{v}=\frac{c}{\sqrt{\frac{\nu}{2\pi\mu\sigma}}}, \quad \text{or}$$

$$n=c\cdot\sqrt{\frac{2\pi\mu\sigma}{\nu}}$$

which is dependent on the color of the incident light, as may be seen by the fact that the frequency ν enters into the relation.

Electromagnetic theory has also given us a method for measuring the dipole moments of gases, with the use of the equation by Lorenz and Lorentz. The specific refraction [r] is given by

$$[\mathrm{r}]=\frac{1}{d}\cdot\frac{n^2-1}{n^2+2}$$

where d is the density, and n the refractive index of the refracting medium. The Clausius-Mosotti relation is obtained from this by the substitution $n^2=\kappa$

$$P=\frac{1}{d}\cdot\frac{\kappa-1}{\kappa+2}$$

where P is a measure of the polarization of a molecule. Both of these relations are useful in physical chemistry for the empirical determination of features of molecular structure.

Other applications of this theory include the explanations of the phenomenon of polarization; of the Faraday Effect (where the plane of a beam of polarized light passing through a dense transparent medium is rotated by a magnetic field impressed on the medium); and Zeeman Effect, where the value of e/m for an electron, derived from considerations of light emission by atoms in a magnetic field, agrees very closely with that value obtained by J. J. Thomson in his classical experiment.

But the greatest triumph of electromagnetic theory was the prediction of the existence, and possibility of production, of waves in ether with very great lengths (now called radio waves). The generation was achieved by Hertz, by means of oscillatory discharge of a condenser through a resistance. He was able to derive mathematically an expression for the charge flowing in such a circuit, in terms of the resistance R, the capacity of the condenser C, and the self inductance of the system L. This expression is too long to give here, but one factor entering into it is the term $\sqrt{R^2-(4L/C)}$. The interesting point about this is the fact that if R^2 is greater than $4L/C$, the condenser dis-

charges smoothly. But if R^2 is less than $4L/C$, the term given above becomes imaginary, and the entire equation seems to have no meaning. Nature responds to this by giving way to an oscillatory discharge, which produces electromagnetic waves. Upon being measured these waves were found to have the velocity C, and since they were shown capable of being reflected and polarized it could be proven that these were of the same species as light waves. To the same category of phenomena belong infra-red rays, visible rays, ultra-violet rays, X-rays and Gamma rays. These differ only in wavelength, as shown in the following table of the electro-magnetic spectrum:

Name	*Wave Length*
Hertzian (Radio) waves	2×10^{6} to 0.20 cm.
Infra-red	$0.031 - 7.2\times10^{-5}$
Visible	$7.2\times10^{-5} - 4.0\times10^{-5}$
Ultra-violet	$4.0\times10^{-5} - 2.0\times10^{-6}$
X-rays	$5.0\times10^{-7} - 6.0\times10^{-10}$
γ-rays	$1.4\times10^{-8} - 10.0\times10^{-10}$

There are some radiations that are typically corpuscular in nature. These are β radiations which consist of electrons moving with velocities approaching that of light. But this corpuscular nature is obscured at their great velocities because an apparent increase in mass is observed, as was predicted by Lorentz and his school. Better examples are α rays, since these consist of particles of large mass traveling relatively slowly. Their momentum and charge are easily measured. But in both of these cases it is possible to observe the effects of interference, which indicate that these rays are associated with some sort of wave motion. This fact, and others have led to the development of the quantum theory; which does not do away with electromagnetic theory, but rather extends this to include atomic and other critical phenomena (such as the photoelectric effect). For this reason electromagnetic theory has retained its importance and value to men of science.

GO WEST BUT TAKE IT EASY

Horace Greeley might have added a safety note to "take it easy" when he advised young men to go west. For the young men who took his advice—and those who have followed them—have given the western United States the highest accidental death rate in the country.

The 1948 edition of "Accident Facts," statistical yearbook of the National Safety Council, points out that the accidental death rate per 100,000 population averaged 102 in the Mountain states and 82 in the Pacific states in 1947. The lowest average rate was the 60 of the North Atlantic states; followed by the North Central states with an average rate of 69.

The accidental 1947 death rate for the entire United States was 69.7.

A PRESSURE-VOLUME RELATIONSHIP DEMONSTRATION

L. A. Kirst
Senior High School, Orlando, Florida

The demonstration here described is simple and involves nothing new. It is submitted because it is probably not generally performed, and because its effect on a class warrants its performance.

In the figure here shown an aspirator attached to a water faucet is used to reduce the pressure above the water surface to about one centimeter of mercury, or less. An inverted heavy test tube with some air in it will lose most of this air. It bubbles out at the bottom of the tube as the pressure is reduced, and the remaining air completely fills the tube. This is in accord with Pascal's Principle that pressure on a confined liquid is transmitted without loss to all containing walls, only in this case it is reduced pressure which is transmitted.

In most class room demonstrations, such as that of the Cartesian Diver and similar ones, increased pressure with relatively small volume change is had. When normal room pressure is reestablished by the controlled admission of air thru the tubing the air will shrink to about one per cent of its previous volume and occupy a volume about the size of a pea. This volume change is much greater than that which occurs in Boyle's Law experiments.

For the test tube a graduated tube may be substituted, and a mercury manometer may be added. The pressure-volume products can be computed and shown to be in accord with the gas laws. The volume can be regulated by varying the rate of flow of water thru the faucet.

THE EXTENSION OF THE EXPONENT CONCEPT

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1. In a recent note (Elementary Derivation for Complex Exponent, School Science and Mathematics, February, 1948), Mr. W. R. Ransom presented an interesting method for the derivation of the meaning of complex exponents. The method is designated as a heuristic proof which clearly indicates that the author does not consider the exposition to constitute a mathematical proof.

In the same issue Mr. C. B. Read (Criticism of Certain Aspects of High School Mathematics Texts) also comments on the subject of generalized exponents but from a completely different angle. While reviewing various mathematics textbooks, Mr. Read found in a number of them "proofs" that $x^0=1$ and that $x^{-n}=1/x^n$. The sections of the paper dealing with this topic briefly point out that such proofs are fallacious unless a special postulate is introduced to the effect that "the laws of exponents developed for positive integers must hold for negative and zero exponents."

In the opinion of this writer, the very fact that such fallacious expositions still appear in recently published textbooks is ample evidence that some educators fail to see what is wrong with the proofs which are criticized. This in turn implies that these people do not have a clear idea of the logical bases of mathematics. It is believed, therefore, that a useful purpose would be served if the fallacy of the proofs referred to before were explained in greater detail. At the same time an attempt will be made to indicate a method of how to extend the concept of exponent without resorting to heuristic proofs which may even add to the confusion.

2. Let us first see what is wrong with the proof that $x^{-2}=1/x^2$. The "proof" would in essence proceed as follows:

For divisions of the type $x^m \div x^n$ where $m>n$, we found that the quotient equals x^{m-n}. Hence, $x^m \div x^{m+2}=x^{-2}$. But

$$x^m \div x^{m+2}=\frac{x^m}{x^m\cdot x^2}=\frac{1}{x^2}\cdot$$

Thus, it follows that $x^{-2}=1/x^2$.

The first question to ask is whether zero and negative exponents have any meaning in the sense which is accorded to a positive integral exponent. It will be recalled that the latter may be defined as a number which shows how many times another number called the base

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repeats itself as a factor in a product. Symbolically, $x^m = x \cdot x \cdot x \cdots$ (m times). This makes good sense and is easily understood. But does it make sense to speak of a product in which a certain factor repeats itself 0 or -2 times? There just are no such products in the accepted meaning of this term. If this be conceded, one can readily see that zero and negative exponents constitute symbols which are completely different from their positive integral counterpart.

3. The second question is whether the rule of subtracting exponents can be applied without restrictions in "as a matter of fact" manner. At this point, it may be worthwhile to draw an analogy between negative exponents and negative numbers in general. Suppose for a moment, that our concept of numbers has not been developed beyond the natural number, i.e. positive integers. Within this scheme, we explain the four basic operations in the most elementary manner. There will be no trouble with addition and multiplication since the sum or product of two natural numbers are always natural numbers. But, subtraction and division will not offer such smooth sailing. A division like $12 \div 3$ can be done because it results in a natural number. However, $12 \div 5$ cannot be done within our restricted number scheme. Similarly a subtraction of the type $4-6$ cannot be done since it will certainly not result in a natural number.

The subtraction $4-6$ does not even make sense in the usual way. An explanation which is proper for subtractions of the type $6-4$ would break down completely for the subtraction $4-6$. It is possible to take away 4 objects from a group of 6 objects while the reverse simply cannot be done. The same type of difficulty arises when an explanation which is proper for $12 \div 3$ (divide 12 objects in 3 groups with an equal number of whole objects in each group) is attempted for $12 \div 5$.

4. It can thus be seen that so long as our number scheme consists only of natural numbers division and subtraction are not always possible. The restrictions can be removed only by the introduction of new types of numbers namely, zero, fractions, and negative numbers. Now, instead of the body of natural numbers we have a larger one consisting of all rational numbers. Within this enlarged scheme the four basic operations are possible in all cases with the exception of division by zero.

In the case of exponents, the situation is very similar. The rule of adding exponents can be applied without restrictions within the scheme of natural exponents. However, the rule of subtracting exponents is valid within this scheme only so long as the quotient is a power with a natural exponent. When the rule would lead to the subtraction of equal exponents or to the subtraction of a larger exponent from a smaller one it has to be discarded as inapplicable just as the

subtraction $4-6$ must be discarded before the introduction of negative integers.

5. The faults of the proofs for zero and negative exponents can now be briefly summarized as follows:

a. The definition of a natural exponent makes no sense for zero and negative exponents.

b. In mathematics, terms cannot be used before they are formally defined unless they belong to the small group of basic terms accepted without definition.

c. In the absence of a special postulate, as long as the concept of exponent is not extended beyond its meaning for natural numbers, the rule regarding the subtraction of exponents in division is restricted only to cases where the exponent of the dividend is larger than that of the divisor.

d. The criticized proofs take for granted the applicability of the rule of subtracting exponents in all cases. Furthermore, the formulation of the theorems themselves is faulty insomuch as they contain terms which have not been hitherto defined.

6. From the point of view of rigorous formality, the introduction of a special postulate which would extend the rules applicable within the scheme of natural exponents to other situations would be sufficient. To avoid the use of undefined terms in the formulation of the postulate itself, it would be necessary not to use the terms 'zero exponent,' 'negative exponent' and the like. This difficulty could be overcome by reference to operators or symbols instead of exponents other than natural.

This approach, however, is not feasible on the high school level. The writer has serious doubts whether this treatment will be appreciated even by the usual college student. It would thus seem best to introduce generalized exponents by definition, and to utilize the occasion for a discussion of the gradual expansion of the number concept from positive integers to fractions, to zero, to negative numbers, to irrational numbers, to complex numbers, and, if desired, to numbers of still a more general type. The topic may be presented without regard to chronological developments since the purpose of the discussion is to give a logical rather than a historical pattern.

7. It was pointed out before that subtraction and division are not always possible within the framework of natural numbers. Unless the number concept is extended, these two operations would be applicable only under severely restricted conditions. Had mathematicians been willing to accept such restricted activity, most of the modern technological marvels would not have been possible. Most of the sciences which either directly or indirectly depend on mathematics would probably still be in a very primitive stage. This point ought to be

stressed in order that the student should appreciate the far reaching results of mathematical generalizations.

The introduction of fractions removes the restrictions on division. However, the definition for division must also be modified. When we deal with a division of the type $12 \div 5\frac{1}{3}$ we cannot define it in the same way as $12 \div 4$, that is in terms of dividing a group of 12 objects into 4 equal parts. The new definition must be less specific and of necessity less intuitive.

It is obviously desirable that the new definitions and rules should be set up in such a manner that the old ones should fit in the scheme. Thus, for instance, rational numbers are purposely so defined as to remove the restriction on division. We may first define a positive rational number as the result of an operation (as yet unspecified) on two natural numbers m/n such that $m/n \cdot n = m$. Now, it is not any more necessary to introduce new postulates regarding the general applicability of division. The division of $a \div b$ may be defined as an operation leading to a result c such that $bc = a$. Within this scheme, if a and b are positive rational numbers c will also be a positive raitonal number.

8. The introduction of fractions removes the restrictions on division but has no such effect on subtraction. To broaden the applicability of the latter new kinds of numbers must be introduced. These are zero-and negative numbers. The procedure is again similar to that outlined before for division. Zero is defined as a number such that $a+0=a$. The negative $(-a)$ is defined as a number such that $(-a)+a=0$. Now, it is possible to give a generalized definition for subtraction $a-b$. The result of this subtraction x is such that $x+b=a$. Our number concept has thus been extended to contain positive integers, positive fractions, zero, negative integers and negative fractions. Within this new scheme of rational numbers all four arithmetic operations are possible without restrictions excepting division by zero.

In this connection, it may be useful to point out that theoretically the restrictions on subtraction, for instance, could be removed in a manner different from the one which has been actually followed. We could define subtraction as follows "Whenever $a>b$, $a-b$ has the usual meaning. Whenever $a \leqq b$, $a-b$ will be taken as equal zero."

Under such a definition, there would be no consistency between the rules for the particular cases. Thus, when $a \geqq b$, we have $a-b=x$ and $x+b=a$. However, when $a<b$, the above relation would not hold. By showing these relationships, the teacher will impress upon the student the very important fact that mathematical generalizations are purposely so designed as not to break down the continued applicability of old knowledge, unless such old knowledge has been found to be erroneous.

9. At this point the student's attention may be called to algebra. After the meaning of equations has been briefly reviewed the teacher may proceed to show that the body of rational numbers is sufficient for the solution of all equations of the type $ax+b=0$ where the coefficients are any rational numbers provided that a is not zero.

When the solution of second degree equations is attempted situations immediately arise where a solution cannot be affected in terms of rational numbers. The equation $x^2-2=0$ is a case in point. Thus, a further extention of the number concept becomes necessary. That is where the irrational numbers come in. At the secondary or junior college levels it may be best to state that a formal definition of irrational numbers is beyond the scope of an elementary course. The necessity for having such numbers should, however, be carefully explained. It should also be made clear that $\sqrt{2}$ is a new kind of a number completely different from any rational number.

Further examination of quadratic equations will lead to the introduction of the imaginary unit and to complex numbers. Such a simple looking equation as $x^2+1=0$ cannot be solved within the framework of real numbers (rational and irrational numbers). The important fact to stress is that these new numbers are introduced in such a manner as to make a real number a particular case of a complex number. This means to say that a real number x may be written as $x+0i$ and that there is a consistency between the operational rules developed for real numbers and those applicable to complex numbers.

10. The analogy between generalized numbers and generalized exponents is obviously not complete. In the first case we are enlarging the body of numbers by introducing new kinds. In the second case we are only enlarging the meaning of a symbol but no new kind of number is hereby introduced. However, in both cases the generalizations lead to the removal of restrictions which would otherwise have to be retained. Also, in both cases have the generalizations been devised in such a way as to be consistent with definitions and rules previously established.

The writer believes that a careful presentation of the topic dealing with generalized exponents may result in a better understanding, on the part of the student, of the purpose of mathematical investigations. On the level on which the topic is considered, a discussion of the type presented in the preceding sections should not be too difficult to handle. Heuristic proofs of the kind given by Mr. Ransom are in the opinion of this writer somewhat dangerous especially if care is not taken to point out why the exposition cannot be considered a mathematical proof. If handled properly, the heuristic method could be a very valuable tool to show how the generalized exponents fit within the scheme established for natural exponents.

Summary

The writer believes that the topic of zero and other generalized exponents should be handled as follows:

1. Present a fallacious proof and point out why it is wrong.
2. Discuss the gradual generalization of the number concept stressing the desire for continuity in all generalizations.
3. Introduce generalized exponents by definition, that is define x^0 as equal 1 and x^{-n} as equal $1/x^n$ explaining that the definitions hold only for $x \neq 0$. If more general types of exponents are discussed, they should also be introduced by definition.
4. Show that once proper definitions are given the old rules automatically acquire a more general applicability.
5. If desired, present a heuristic proof, but not before the subject has been thoroughly discussed. In any event, point out the nature of a heuristic proof as contrasted with a formal logical proof.

NINTH CHRISTMAS CONFERENCE OF THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

The National Council of Teachers of Mathematics will hold its Ninth Christmas Conference at Ohio State University, Columbus, Ohio, on Wednesday and Thursday, December 29 and 30, 1948. Six sectional meetings will be held devoted to problems relating to the teaching of high school and junior college mathematics and the preparation and in-service training of teachers.

At the Thursday morning session, opportunities for discussion of important questions in mathematics teaching will be offered by attending one of seventeen discussion groups and clinics under the leadership of individual classroom teachers. Topics to be considered include questions involving the contents of courses in algebra and general mathematics, instructional and learning aids, guidance, tests, teaching of statistics in the high school and junior college, coordination of high school and college mathematics programs, and applications of mathematics in business and industry. The latest films and filmstrips will be shown at various periods during the two day conference.

Headquarters for the meeting will be in Baker Hall. Reservations for rooms in Baker Hall should be made by writing directly to Mr. Oscar Schaaf, Room 120 Arps Hall, Ohio State University, Columbus, Ohio not later than December 15, 1948.

A copy of the program may be obtained by writing to the National Council of Teachers of Mathematics, 212 Lunt Building, Northwestern University, Evanston, Illinois.

ASPARAGUS WASTE USED

Waste asparagus butts are helping produce antibiotic to fight disease. The Western Regional Research Laboratory of the U. S. Department of Agriculture has discovered that concentrated juice from the vegetable waste can be used to grow Bacillus subtilis, which produces a new antibiotic, subtilin.

An estimated 70,000 tons of asparagus butts are discarded each year by processing plants.

CRATER LAKE—A GEOLOGY LESSON FOR YOUTH OF JUNIOR COLLEGE AGE

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Introduction

With the increased emphasis on the importance of general education for all American youth, a problem has arisen regarding the type of textbook materials suitable for such education. It is interesting to attempt to compose materials from technical sources that will have values for all people rather than for only those who are planning to specialize in geology.

It remains an unanswered question how well materials can be composed so as to transmit some of the technical knowledge of geology and yet instill a degree of appreciation of the significance of our environment, respect for the methods used by scientists, and provide nourishment of the natural curiosity with which we are all endowed.

A Geology Lesson at Crater Lake

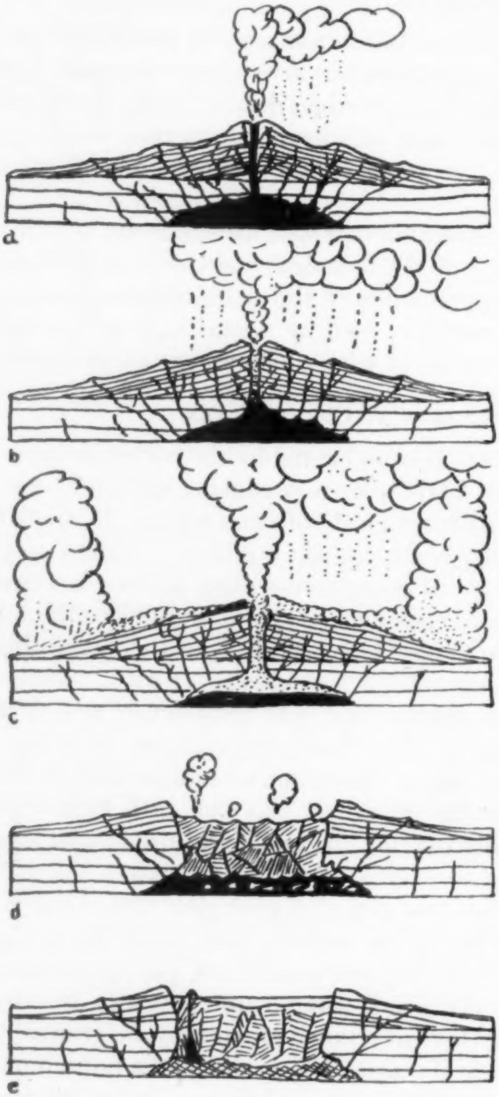
Most of our study of geology is complicated by the enormous lapse of time since the occurrence of the events producing geological features. Such is not the case with the study of Crater Lake. If we had visited the Crater some 5000 years ago we would have found only such a mountain as is now typical in the surrounding landscape. If we had visited the Crater but a thousand years ago we would have found no Wizard Island present in Crater Lake. Truly does this make this a really modern geological feature.

It was a group of Indian fighters and gold prospectors who first happened upon Crater Lake in 1853. However people in those days were interested in the West only as the home of Indians and as the place where gold had been discovered. It was not until 1885 that interest became active in discovering the geological origin and significance of Crater Lake.

Near the close of the Pleistocene period of geological time, lava began to flow from an opening in the earth's crust near where the Phantom Ship is now located. This brown-crusted, pale-green lava built up a cone, the height of which it is impossible to guess. Nearby began another outpouring of lava at a much greater rate to gradually build the cone now known as Mazama. The gushing lava poured out over the area around the escaping vent, building up in layers, and covering the Phantom Ship cone. Periods of inactivity would be followed by eruptions without enough time between to allow erosion to wear away the previous layers of the developing cone. Later the pe-

riods of eruption were so violent as to provide enough eruptive materials to form a layer of lava on the cone a hundred or more feet in thickness.

If we study Figure 1 it can be seen that in addition to the main vent out of which lava would rise there are smaller vents branching out to



a. Beginning of culminating eruptions. Magma high in conduit; mild eruption of pumice.

b. Activity increases in violence. Showers of pumice more voluminous and ejecta larger. Magma level lowers to top of feeding chamber.

c. Activity approaches the climax. Combination of vertically direct explosions with glowing avalanches (*nuees ardentes*). Chamber being emptied rapidly; roof commencing to fracture and founder. Magma also being drained from the chamber through fissures at depth.

d. Collapse of the cone as a jumble of enormous blocks, some of which are shown sinking through the magma. Fumeroles on the caldera floor.

e. Crater Lake today. Post-collapse eruptions have formed the cone of Wizard Island and probably have covered part of the lake bottom with lava. Magma in the chamber largely crystallized.

FIG. 1. The evolution of Crater Lake.[1]

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[1] Adapted from Williams, Howel, *The Geology of Crater Lake National Park, Oregon.* Carnegie Institution of Washington Publication 540, Washington, D. C. 1942. p. 104.

come to the surface somewhere up the side of the cone. At times small eruptions would come pouring out of these small parasite vents to form smaller cones on the sides of the main cone. This explains such small cinder cones as Bald Crater, Desert Cone, Red Cone, Forgotten Crater, and nine or ten other similar cones in the Crater Park area.

With increased activity additional lava flows collected on the cone some of which formed layers four to five hundred feet thick. This continued until a mountain about 12,000 feet high had been formed. The cold climate of the Pleistocene period allowed large glaciers to

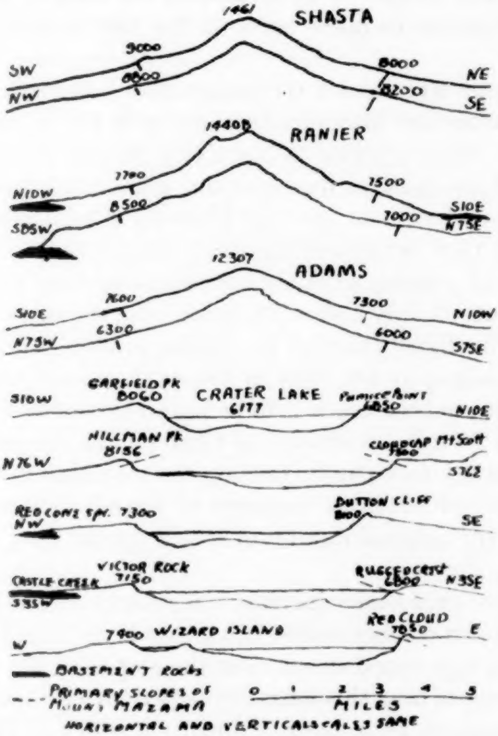

FIG. 2. Profiles through Mounts Shasta, Rainier, and Adams, and Crater Lake.[2]

cover the sides of the developing cone producing an abnormality of Nature that is difficult to conceive. Within this cone at the base of the issuing vent molten lava with accumulated cinders and ash was to be found with occasional steam issuing from the side or branching vents. On the walls of the cone large glaciers were forming and pushing down the sides of the cone.

The exact form of the cone, from now on to be known as Mount

[2] Williams, H., *op. cit.* p. 64.

Mazama, has been estimated by geologists by comparing the crater left at its base with other mountains of the Cascade Range. How this was done and the results obtained may be understood by study of Figure 2.

With the change in weather that came with the close of the Pleistocene period the glaciers melted from the base of the mountain and only extended down as far as the present crater in a few places. The deep, U-shaped troughs of Munson, Sun, and Kerr valleys show where these glaciers were. The mountain remained in this condition long enough for heavy forests to form around the base of the mountain. Enough time passed to allow some of the thin layers of lava to be eroded away.

Now the scene was set for the action that has made from Mount Mazama a feature the likes of which are to be found nowhere else in United States. After a period of inactivity Mount Mazama again became active. First, pumice dust and fine ash and cinders began to be exploded from the vent at the top. First these explosions were weak but the longer they continued the more violent they became and the larger chunks of pumice were not carried away over the countryside by the wind but fell only a short distance from the cone. More pumice came later. The distribution of the falling pumice followed the wind direction prevailing at the time of the explosions. Only a very thin layer of the erupted materials is to be found on the west of the Crater whereas up to 70 miles northeast of Crater Lake the pumice fell in a sheet that is still a foot thick. Tracing the materials erupted in these final explosions of Mazama becomes of importance in determining how much of the original mountain is still spread over the surrounding area.

The eruptive explosions increased regularly and often. Soon the lava being thrown out became so thick that it no longer was shot into the air but merely oozed down over the slopes of the cone. Fed by new outpourings of lava this mass developed into a glowing avalanche gaining momentum as it poured down the sides of the cone. This avalanche was a flaming, hissing, exploding mass of semi-solid magma containing gases under high pressure. Occasionally a large bomb-shaped mass of lava would be expelled from the cone and come bursting down on the avalanche throwing exploding chunks of lava in all directions.

It was natural that the flowing lava would follow the canyons and valleys of the slope. Riding as it was on a cushion of trapped gases its speed of travel reached well over an estimated 100 miles an hour.

The flows rushed down the canyon of the Rogue River for 35 miles. Northward they spread across Diamond Lake, 13 miles from the vent, and emptied into the headwaters of the North Umpqua River; southward they poured down the canyons of Annie and Sun creeks; southeastward, they raced down Sand creek,

and even after reaching the foot of Mount Mazama continued across the flats for more than ten miles; eastward, the flows poured out of the mouths of the canyons and spread no less than 25 miles from their source.[3]

This account of the building up of activity in old Mount Mazama has come from piecing together the bits of evidence around the cone. It is interesting to compare this account with an account of observed conditions of volcanic eruption as recorded by an observer of Vesuvius. Frank A. Perret,[4] living as he was on the slopes of Mount Vesuvius during 1903 to 1906, was able to observe and record the behavior of a volcanic cone building up to explosive violence. Perret presents his account with such wonderful vividness that it will be presented with but minor adaptations.

The writer's acquaintance with Vesuvius dates from the latter part of 1903. . . . On several occasions true flames of burning gas were visible, crowning the crater with a halo of pale fire. These flames were faintly luminous, slightly blue or bluish green in color, and were due to fumarolic exhalations consisting, most probably, of burning hydrogen or hydrogen sulphide, and constituting thus the somewhat rare phenomenon of flame-emitting fumaroles. . . .

The explosive activity in December 1903 was moderate, with considerable increase during the month of January 1904. The ejected material consisted quite generally of non-luminous detritus, with occasional projection of a large incandescent mass of lava.

During the entire month of January 1904 the explosive activity of the crater was very considerable, but rarely luminous from a distance, because the lava continued to stand at a low level in the larger basin. During February the activity was considerably lessened. In March, however there was a considerable general increase of activity, including an augmented outflow in the Valle dell'Inferno, which sent lava to the base of Monte Somma.

During the month of September 1904, while the writer was absent from Italy, there occurred an explosive phase which by some was considered the most violent of the entire eruptive period up to that date. This began with the usual cone-building activity, which virtually filled the former crater and culminated explosively during the night of September 23–24. As described to the writer by eye-witnesses, the explosions formed a brilliant spectacle, and from Naples the ejected incandescent masses could be seen rolling and zigzagging in a peculiar manner down the slopes of the cone.

At the end of October the terminal conelet, which had formed within the main crater as a result of the explosive activity, collapsed, causing a light shower of ash over the whole region as far as Naples.

From this time onward the activity of the volcano took the form of a persistent tendency toward the maintenance of a high magma column. The rising lava gradually filled the crater, building up within it the usual terminal conelet of fresh scoriae.

On April 19, 1905, after an interval of four days, during which time the summit of the mountain had been hidden from view by a severe snowstorm, through which the ruddy glow of intensive explosive activity was translucently visible in wondrous contrast with numerous blue-white flashes of lightning, the inner conelet was seen for the first time emerging above the rim of the main crater, and the terminal activity could thus be observed from a distance.

While watching the mountain from Naples at 6^h30^m in the afternoon of May 27, 1905 a cloud of white vapor was seen to shoot horizontally from the side of

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[3] *Ibid.* p. 79.

[4] Perret, Frank A., *The Vesuvius Eruption of 1906*, Carnegie Institution of Washington, Washington D. C. 1924. pp. 17–57.

the cone at some distance below the terminal vent. In a few seconds there appeared through the vapors the red glare of lava, which later as the cloud lifted was seen to be descending the cone in a brilliant stream of fire. A second vent soon opened, followed by a third, all simultaneously in action in spite of a considerable difference of level. Soon after the outflow of lava began the activity of the crater suddenly ceased, with partial collapse of the terminal conelet, but the explosions soon recommenced with ejection of the collapsed materials.

During the last days of June 1905 the lava ceased flowing from the uppermost vent, and from this time the entire outflow as limited to the lower mouth. . . . During the remainder of the year 1905 the flowing lava upon the northwest flank of the cone formed a brilliant spectacle of great variety. . . .

We thus come to the eventful year 1906!

It is easy for one looking back at this period to see that the continued resistance of the main cone throughout this long attack upon its integrity presaged an eventual fracturing. . . . Already, on January 31, 1906, from the crest of Mount Somma the crater was seen to be in a state of suppressed activity which can best be described as an ugly mood, and on February 2, 1906, the outflow of lava increased to full, free-flowing streams, clear and liquid throughout their length. On the morning of February 7 the eruptive phase culminated in paroxysmal conditions at the main crater, with long, roaring explosions and the emission of clouds of ash, which with the advance of the glowing and hissing tongues of lava, formed a manifestation of no inconsiderable volcanic activity. Still the walls of the great cone held fast.

Again the eruptive forces subsided, with continual variations, until the vernal equinox, when a powerful phase of pure "Strombolian" activity began with lofty jets of wholly liquid, intensely brilliant lava accompanied by the well-known salmon-colored vapors.

During this visit to (February 16) Vesuvius, the writer, at night in bed, thought he could hear a continuous buzzing sound which seem to come from below. When he set his upper teeth against the iron bedstead he heard the sound more positively, and there could be no doubt of its objective existence. Had he then possessed the microphone apparatus since developed, the revelation of this premonitory symptom of the great eruption would have been more positive and definite.

Nine days later, dense, dark clouds of quite unusual aspect, issuing intermittently from the crater, clearly indicated a breaking down of the terminal conelet, but also of the walls of the cone itself, and there could be no doubt that the long pre-eruptive period had reached its culmination.

We come then to the morning of April 4, 1906. From Naples the usual white vapor was seen issuing from the crater with a subtly but decidedly unusual aspect impossible to describe. As the skilled physician sees in the patient a significant change which to other eyes is not revealed, so the volcanologist, observing the crater on this day, saw there the signature of a new power. And soon into the neatly contoured vapor column there began to be injected masses of dark ash which continued during the day with increased presence of the detritus resulting from a progressive demolition of the upper portion of the cone.

In the meantime the ash-cloud from the crater had, before evening assumed a threatening aspect, with long, dark streamers floating seaward, which a veering wind brought over the city by nightfall, and the Neapolitans went about with umbrellas opened against a dry rain of coarse volcanic sand. During the next day the emission increased in violence, with the ejection of mixed incandescent lava-masses and old cone material, blocks of which already fell at a distance of several hundred meters from the crater. Following the stronger explosions (and especially those most densely charged with ash), there began to appear in the midst of the crater-clouds those visible electrical phenomena which later formed so important a feature of the eruption. At this time they consisted of tiny brilliant lightning-flashes produced by the powerfully projected jets of ash and the sounds were as sharply staccato as pistol shots in the open air.

At 3^h30^m a.m., April 8, there began the true dynamic culmination of the great eruption, with a literal unfolding outwardly of the upper portions of the cone in all directions, like the falling of the petals of a flower. Those who speak of the top of the mountain having fallen in were not eye-witnesses of what occurred. No mass of matter, however great, could descend against the mighty uprush of gas that was now liberated from the depths; at most it could slide down the oblique walls of the cup-shaped cavity, only to be caught by that great blast and tossed upward and outward, like a light ball upon a fountain-jet. This colossal column, with ever-increasing acceleration, was actually coring out and constantly widening the bore of the volcanic chimney. The great blast tore from the walls of the conduit material of the many dikes there exposed and fragments of this compact gray rock now began to fall from the skies till it became necessary to always stand erect and with a rolled-up overcoat held as a cushion upon one's head. At first the size of small nuts, the projectiles gradually increased up to 2 and 3 kilograms in weight, some of which were thrown 4 kilometers from the crater.

By daylight of April 8, the writer looked upward to observe that at the very top of the lofty pillar of cloud, great globular masses of vapor were expanding outwardly against the surrounding air-cushion with incredible velocity, forming "cauliflower heads" with a sharpness of contour and a wealth of detail impossible to describe.

The sound, also, throughout the entire culmination, was an uninterrupted compound note not unlike the roar of Niagara, but with a recurrent crescendo-diminuendo effect giving to this phenomenon, along with all other manifestations of the great eruption, the wave form. Above the curve of dynamic intensity there was superposed these rolling cadences of sound, the seismic pulsing of the ground, and the exceedingly rapid undulations of the electric flashes in the cloud. The great eruption was a sublime manifestation of rhythm.

Strongest of all impressions received in the course of these remarkable events, greatest of all surprises, and most gratifying of all features to record was, for the writer, that of an infinite dignity in every manifestation of this stupendous release of energy. No words can describe the majesty of its unfolding, the utter absence of anything resembling effort, and the all-sufficient power to perform the allotted task and to do it majestically.

There was also the element of awe, in all its fulness. The sense-walls of the universe are shattered by these higher values of power, and Diety is indirectly more in evidence than in the case of lesser things. A blade of grass as surely, but far less forcibly, reveals the truth that That which manifests can not be seen, nor heard, nor felt, except through and because of the manifestation.

At Naples, on the day of April 8, conditions were indescribable. The earth-shocks of the night before had produced a state of panic, and 100,000 persons, it is said, left Naples in five days. The morning of April 9 revealed the emission of a truly imposing volume of ash, apparently from a greatly widened crater, but under a gas pressure so reduced as to constitute a radical change from the conditions of the previous day. There thus had supervened the (third) last and longest phase of the eruption. Near Resina the downward blasts of ash and sand became so heavy that a horse could not proceed. Still farther on and more especially upon the mountain itself, the down-sweeping ash became conglomerated through condensation of the water vapor in the crater-cloud forming balls of soft mud, some as large as an egg.

By April 9, ash was falling heavily but dry, and with it fell countless living caterpillars. April 11 was for us at the Observatory in part a day of darkness. The ash fell heavily, this time bringing many flies.

At 7^h40^m. a.m. of April 12 a strong seismic shock was felt and again throughout the day the Observatory had heavy showers of ash. A force of sappers was brought up from Resina, and from one roof terrace alone six tons of this material was cleared.

On April 22 the eruption, dynamically, was virtually at an end, as the seismoscopes often stood motionless for hours at a time, and the crater cloud of ash and

gas—though still rising majestically and in successive puffs due to soft explosions—had an ascensional power barely sufficient to raise its heavy content of ash.

On April 28, at 6^h40^m a.m. there was an explosion with strong agitation of the instruments, and as a result of the abundant rainfall one of the great "mud lavas" was formed, which flows, by invading the Vesuvian towns, were the cause of much damage and loss of life.

On April 30 all was quiet.

It is true that no observers were present to record the series of events leading up to the final destruction of old Mount Mazama. Having read this account of the final eruption of Vesuvius, it becomes interesting to wonder whether Crater Lake has had just as magnificent a history.

Earlier mention was made of the forests that covered the slopes of Mount Mazama near the bases of the cone. It is the presence of charred logs in the lava around the crater that forms the evidence allowing this conclusion to be reached. The lack of these charred logs in the lava farther away from the crater is evidence indicating that the wind deposited the lava at a greater distance from the vent. Being carried by the wind it would be so cooled as to not set afire the forests among which it fell.

It is known that Indians were living on the plateaus around Mount Mazama at the time of this last great eruption of lava. It is interesting to wonder what these people did as the flaming avalanche poured down the slopes of Mazama. As to this one can but theorize but there is evidence to show that there were people in the area during the periods of eruption.

A mat made of shredded sagebrush bark, some sagebrush rope, a two-ply twisted basketry warp, the butt end of an atlatl point, and chalcedony and obsidian scrapers, . . . a rich collection of bones . . . of bison, mountain sheep, camel (probably, *Camelops*), horse, a large dog (wolf), a fox, and probably bear[5]

are the things that have been found in excavations and caves around the crater to indicate that Indians were in the neighborhood at the times of these final eruptions.

Attempts to explain the disappearance of Mount Mazama and the appearance of the present crater, more accurately referred to as a caldera, shows well how the solution to a complex problem often begins with a simple observation. By carefully measuring the amount of pumice and lava that was erupted by the volcano and comparing this amount found spread over the surrounding countryside with the probable original size of the cone a discrepancy was found. About 17 cubic miles of the old cone had disappeared but only about 5 cubic miles of materials had been scattered over the surrounding area. This could lead to but one conclusion.

[5] Williams, H., *op. cit.* p. 115.

The summit of Mount Mazama was engulfed by withdrawal of magmatic support from below. This withdrawal was caused partly by rapid eruption of pumice and scoria from the upper part of the magma chamber, but principally by injection of magma at greater depths, probably into swarms of fissures.[6]

After having swallowed its summit, Mount Mazama remained rather quiet for about four thousand years. There may have been occasional minor eruptions of lava during this period of quiet but at the end of that time there occurred the eruption that produced the cinder cone of Wizard Island. The size and roundedness of the particles making up this cone are such as to indicate that materials were thrown into the air by the eruption and fell back to form the little cone within the Lake. The age of the trees on Wizard Island presents evidence that the island is about 800 years old. The recency of this date makes it a rash idea to think that no more disturbances will come from old Mount Mazama.

[6] *Ibid.* p. 107.

IS YOUR RADIO DIAL CALIBRATED CORRECTLY?

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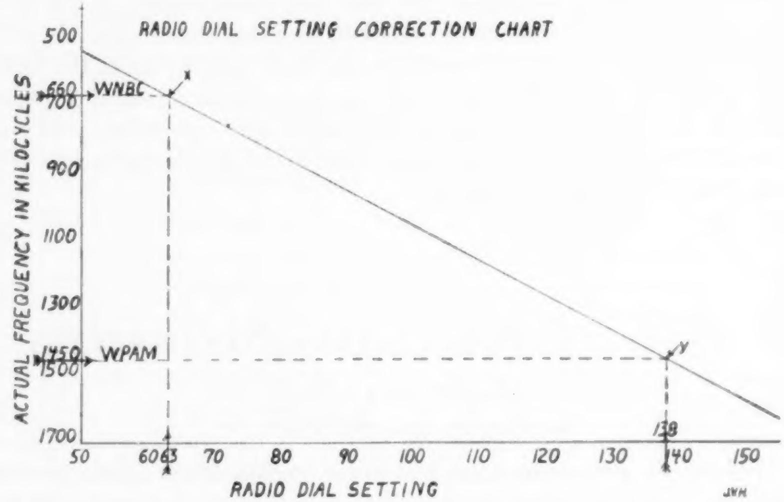
Millions of American homes contain radios whose dials do not conform to the frequency to which the radio itself is tuned, and for this reason, tuning to a definite frequency is made rather uncertain. The reasons for this out-of-calibration are many, outstanding of which are: improper design by manufacturer; use and age; heat and humidity; handling; parts replacements, especially those not recommended by the manufacturer; poor condenser tracking; improper repair, etc.

This uncertainty of tuning can be remedied simply by constructing a graph or chart as described below; and, by following it through, one can determine the exact frequency to which his radio is tuned at any setting of the dial.

On a sheet of graph paper, divide the horizontal and vertical axes as shown in the example. On the vertical axis indicate the actual frequency in kilocycles, and on the horizontal axis indicate the radio dial settings. Tune in a radio station on the lower end of the dial—in the case of the graph shown, it was station WNBC, 660 kilocycles—and note the number of the dial setting—in this case it was 63. Where the two lines meet (660 and 63), mark a small dot as shown in the example (X). Next tune in a station on the upper end of the dial, and proceed as before, marking a small dot where the two lines intersect. In the graph shown, the station was WPAM, and the frequency

was 1450 kilocycles. The dot, of course, was made at point (Y), because this station now came in on the dial at 138. Now, with a straight edge connect the two dots. This line represents the difference between the frequency to which your radio is tuned, and the number of the dial setting. It is a simple matter now to determine the exact dial setting to which your radio will tune to a given radio frequency or station.



EXAMPLE: Using the graph shown, to what setting on the radio dial must I turn to tune to radio station WOR, 710 kilocycles?
ANSWER: Since 710 on the vertical axis meets the correction line at point 67 on the horizontal axis, you turn the radio dial to 67 to tune to radio station WOR.

The graph in this example was prepared for a Crosley, Model 157.

CONVENTIONAL PLUS JET POWER FEATURE NEW NAVY CARRIER-BASED PLANE

Conventional engines plus jet propulsion feature a new Navy plane, now revealed. It is designed for carrier operations. Two reciprocating engines are located under its wings, and a turbo-jet engine is in the tail of the fuselage.

In normal operations, the conventional engines will be used. When added speed is needed, the jet can be cut in. The reciprocating engines are Pratt and Whitney Wasp Majors, and the jet is a GE-Allison turbo-jet.

This new plane, which has already completed initial flight tests, was constructed by North American Aircraft Company, Los Angeles. In service it will be known as the XAJ-1. It carries a crew of three, has tricycle landing gear, high wing, and four-bladed propellers. Outer wing panels fold inboard and the vertical tail folds onto the right surface of the horizontal tail.

Performance figures are not yet available, but it will be considerably faster and able to carry a heavier bomb load than present carrier types.

NATURE AND CONSERVATION PROGRAMS IN THE FAR WEST WITH SPECIAL REFERENCE TO CALIFORNIA

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Within the past two decades all far-western states have perforce been concerned with conservation in its many aspects. It is in these states that we find great developments in constructing dams, harnessing water power, developing irrigation, maintaining large national parks, and operating large national forests. The struggle between sheepmen and cattlemen may be now chiefly of historical interest in most areas; but there remain many serious problems, and I am willing to assert that western congressmen are in general more aware of great conservation problems facing our nation than those nearer the national capitol.

Since 1930 all of the states west of the Rockies have given consideration to the inclusion of nature and conservation education on both elementary and secondary levels of the public schools. Science studies have been incorporated in the curriculum outlines of these states. Nature study and elementary science textbooks have been adopted by the State Departments of Education of Arizona, California, and Nevada. Separate courses of study in these fields have been prepared and published by the State Departments of Education of Oregon, Arizona, Arkansas, and California. The cities of Bellingham, Seattle, Tacoma, and Spokane, Washington have published separate outlines for elementary schools, as has the city of Portland, Oregon.

One hundred and one years ago Louis Agassiz arrived in Boston. It was not long until his influence had spread westward to the shore of the Pacific. In 1891, David Starr Jordan, one of Agassiz' ablest students became the first president of Leland Stanford University. It is impossible to measure accurately the influence of a great teacher, and Jordan was of that rank. Investment in the lives of students bears compound interest. California has been well blessed with the influence of Jordan and his associates. The work, of Jordan, Mary Rogers Miller, Anna B. Comstock, Mrs. F. L. Griffin, Bertha Chapman Cady, L. W. Welch, Loye Miller, Clelia Paroni, Carrol DeWilton Scott, Vaughan MacCaughey, Annie Harvey, Charles Lincoln Edwards, Roland Ross, Clayton Palmer, Ernest Frasher, and others who participated in the early development of nature study in the elementary schools of California, deserves more than passing mention. These educators were responsible for early programs in Long Beach, Berkeley, San Diego, Los Angeles, Pasadena, and Fresno. In quality

their programs and outlines may be regarded as superior to many of those now developed by so-called elementary science specialists who demonstrate such a lack of child understanding and child psychology as to urge that primary school teachers have their pupils compute how many footpounds of force will be required to lift several tons of mercury, using different arrangements of pulleys and inclined planes!

In 1913 O. J. Kern became a member of the faculty of the University of California at Berkeley. In March 1919, he wrote "Outline Studies on the School Garden, Home Garden and Vegetable Growing Projects." This was distributed throughout the state by the Division of Agricultural Education, College of Agriculture, University of California, Berkeley. It represents, to the best of my knowledge, the first natural science outline published on a statewide basis in California. It was reprinted with certain modifications, February, 1923, under the title *Outlines of Courses of Instruction in Agricultural Nature Study for the Rural Schools of California, Grades 1–8*. The University, through its agricultural extension service, has continued to publish and distribute from time to time, bulletins on gardening, landscaping, agriculture, and other fields related to agriculture; but it is noteworthy that the first attempt to assist elementary teachers in this matter on a statewide basis by means of publications was first developed by its greatest research institution. Furthermore, the university, through the work of its Museum of Vertebrate Zoology, has provided much original natural science information which is continuously being disseminated among the ranks of classroom teachers throughout the state.

In the middle twenties the Fresno State Teachers College began to issue monthly nature study teacher helps under the title of the *Fresno Nature Study Bulletin*. Appearing at first in mimeographed form, sold at cost, and dealing with natural history chiefly of the San Joaquin Valley and its environs, these bulletins found a ready reception and were soon appearing in printed form, though unfortunately in small type and suffering from lack of skilled editing.

Shortly after the *Fresno Nature Study Bulletin* began to appear in printed format, the San Jose State College undertook a more ambitious publication entitled *Western Nature Study*. This elaborate, well-illustrated publication was designed for assisting teachers in service as well as teachers in training. It, too, found a ready reception but suffered seriously from problems associated with financing and distribution. Actually, the second volume of this quarterly was never completed.

In 1932 the California State Department of Education published its first *State Course of Study in Elementary Science*. This work, by a group of Colusa County teachers, was completed under the direction

of Florence Billig, then supervisor of elementary science for the public schools of Sacramento, California. It was limited in its usefulness, however; for different sections of California vary greatly in physiographic features and in flora and fauna.

That same year, 1932, the writer went to Fresno to take over the authorship of the Fresno Nature Study Bulletin. In establishing relationships with the California State Department of Education it was possible to secure the assistance of Helen Heffernan, Chief of the division of elementary education. Her vision and force made it possible to substitute for the *Fresno Nature Study Bulletin* a state department of education publication which appeared under the title, *Science Guide for Elementary Schools*. In August, 1934, the first number of this bulletin appeared under the specific title, "Suggestions to Teachers for the Science Program in Elementary Schools." It was followed by nine other numbers during the 1934–1935 school year; and by June 1941, when the effort was terminated, fifty-two bulletins had been prepared by the faculties of the California State College in cooperation with the representatives of the state department of education. Funds were provided for their publication and distribution from the California state textbook fund, and they found their way into the public schools throughout the state. Most of these bulletins were published in editions of 17,500 to 20,000. "The Fresno Nature Study Bulletin," "Western Nature Study," and the "Science Guide for Elementary Schools" received their stimulus from the enviable "Cornell Rural School Leaflet." They were conceived by individuals close to the Cornell Nature Study program, although each arose independently over a period of years. The method of preparing the "Science Guides for Elementary Schools" was very different, however, from the method used in preparing the "Cornell Rural School Leaflet." The fifty-two bulletins covering the fields of adaptations, amphibia, birds, earth studies, insects, mammals, pets, physical science, plant study, reptiles, sky study, spiders, water life, weather, and methods were prepared by representatives of the seven California state colleges as follows: Chico 7, Fresno 11, Humboldt 3, San Diego 4, San Francisco 10, San Jose 15, and Santa Barbara 2. Thirty-seven staff members of the science department of the California state colleges were represented as authors or co-authors of the science guides issued. Numerous other individuals participated in the program as consultants or assisted in supplying teaching suggestions and illustrations. Certain of the materials were tried out in California public schools before the material was submitted to the printer. Naturally, thirty-seven staff members did not always agree. The material which each prepared was read and in all instances criticized by at least two representatives from other state colleges and in most instances by

many other critics. Every member of the committee had ample opportunity to review the work of other committee members before the material assumed the final form for the printer.

Two detailed studies of the effectiveness of the Science Guides were made at different times and it is hoped that they will be published more fully elsewhere. I may briefly state here that elementary school teachers, elementary school principals, city and country supervisors and superintendents, county librarians, training school teachers, directors of teacher training in the state colleges were agreed in 1943 that the Science Guides had served to stimulate science instruction throughout the state and that they had provided not only specific information and help, but had also developed an awareness of the significance of instruction in this field during the period 1934–1943. An analysis of replies from elementary school principals, superintendents, supervisors, and directors of teacher training indicated that they had not done as much to make the Science Guides effective as elementary teachers under their direction wished. One-fourth of the training school teachers and supervisors indicated that they had given much attention to ways in which Science Guides could be utilized by classroom teachers. Only 10% of the elementary teachers reporting from random selections throughout the state indicated that their superiors had given them direction and encouragement in the use of the Science Guides. Elementary teachers, principals, supervisors, training school teachers, and supervisors were almost unanimous in favoring the modification of the Science Guides from their current form (primarily source materials for teachers in four or more numbers per year) to a new form modified to include a larger annual teacher's number emphasizing organization, presentation and devices, and four or more children's numbers with the content on the reading level of at least intermediate grade. My own judgment is that the Science Guides should have been continued and that they should now be resumed and continued indefinitely as smaller eight, ten, or at most sixteen-page pamphlets restricted chiefly to the physical sciences and the flora and fauna of the State, and prepared on a sixth-grade reading level.

We may frankly state the Science Guide effort was both democratic and sincere. No author received added compensation for extra effort. The work was performed in addition to regular teaching duties. Each author had the opportunity to benefit by sharing views and criticisms with fellow-workers. Science instructors responsible for training of California elementary school teachers were brought to grips with educational problems. Educational leaders throughout the state were made aware of the importance of nature study or elementary science on the modern curriculum. That the Science Guides did

not achieve even greater immediate success cannot be attributed to the authors. If school administrators, elementary school principals, supervisors, and those in charge of directed teaching had contributed equally in this effort more progress would have been attained.

With the termination of the Science Guides for Elementary Schools program the State Department of Education proceeded to adopt elementary science textbooks and supplementary readers for use in grades one through eight. A recent study of how California elementary school teachers use these texts and readers reveals that eighty percent use them as supplementary materials and twelve percent follow them closely.

In August, 1935, it was proposed that steps be taken at once to revise the "California State Course of Study in Elementary Science," which had appeared in 1932. Representatives of the State Division of Elementary Education, the State Colleges, City and Rural Elementary Supervisors, Stanford University, and the University of California were named as a statewide committee on science in the elementary schools with instruction to proceed to develop a new course of study in science for the elementary levels. The original committee of twelve was expanded from time to time. Eventually more than fifty educational leaders in addition to numerous classroom teachers actively participated in the preparation of the 1945 California State Course of Study, "Science for the Elementary School Teacher." This was developed as a combination of systematic and social science type outlines and represents a distinct advance over the earlier effort.

In 1935 the observation of California Conservation Week was inaugurated under the sponsorship of the California Conservation Council. The observance of the week of March 7–14, beginning on Luther Burbank's birthday, intensifies conservation activities in the schools throughout the state and arouses wider public interest through the press and over the radio. For the past thirteen years, under the chairmanship of the Director of the State Department of Natural Resources, state and federal agencies have extended their services during this period to include great stress on educational activities. Pearl Chase, the energetic president of the California Conservation Council, was responsible for the initiation of California Conservation Week and should be credited with its continuance and success. Her efforts were supplemented by those of regional coordinators and county chairmen. The California State Division of Forestry, The United States Forest Service, the United States Park Service, and the United States Soil Conservation Service have been especially active in assisting the schools to properly observe conservation week. The California Conservation Council has been responsible for the preparation and distribution of numerous printed materials

which are regularly used during conservation week or in connection with regular school programs. It has also been responsible for the preparation of a student's guide entitled "California's Natural Wealth" and a bulletin, "Source Materials for Conservation Week." These publications are distributed by the State Department of Education.

In the observance of conservation week the California Division of Fish and Game has also participated. In earlier days this organization had a fine educational program under the able direction of Dr. Harold Bryant who is at present Superintendent of Grand Canyon National Park. Dr. Bryant assisted in the preparation of an excellent publication entitled "Bird Study for California Schools" which had wide distribution throughout the entire state. Later the educational program was greatly restricted, but the Division has continued to publish a semi-popular journal, "California Fish and Game" and to issue such useful publications as "The Trouts of California," "A Study of the Life History of the Mule Deer in California," and a "Handbook of the Common Commercial and Game Fishes of California." For a time a separate journal entitled "California Conservation" was also prepared and distributed. On December 17, 1947, this Division asked financial approval of a 1948–49 fiscal year budget including an item of $80,000 for a new bureau of conservation education. In advocating the education item it was pointed out that people must be taught that the "taking of fish and game is a privilege and not a right . . . that the relationships between farmers and sportsmen are at a low ebb and that cooperation can best be obtained through education." The Division's present educational activities are chiefly restricted to law enforcement, research, and the publishing of the above-mentioned journal, "California Fish and Game."

In 1942 a California Committee for the Study of Education was set up. This committee proceeded to establish a Sub-Committee on Conservation Education. The Sub-Committee has attempted to analyze conservation efforts in other areas of the United States as well as to determine the needs in California. Among the recommendations that have already been submitted to the general committee on a tentative basis are the following:

1) That opportunities in teacher-training institutions for training in the teaching of conservation be increased, the minimum requirements to include: first, a basic informational course given as part of the general offerings to all students, and designed to acquaint the student with the nature, variety and extent of natural resources, and of man's dependence upon them and responsibility toward them; and second, at least one course designed especially for teacher trainees and teachers in service in which methods and techniques of conservation

education are stressed and in which opportunities for teaching conservation throughout the curriculum are explored.

2) That a proposed resource volume on California's Natural Resources be developed and made available to classroom teachers and administrators in California schools.

3) That three reference textbooks for child use be likewise developed; the first book written at the 4–5 grade level; the second book at the 7–8 grade reading level; and a third book at the 9–10 grade reading level and designed for use in senior high schools and junior colleges.

Unfortunately the suggestion has been made that this program be developed in a single state college. It has been pointed out to the present chairman of the subcommittee that the educational forces of the Science Guide for Elementary Schools were enhanced by the pooling of judgments and that any state program is more effective if leaders from many areas of the state join in the effort. Educators will act more quickly and with greater vigor in executing a program which they have helped develop.

A separate proposal to the State Department of Education has come from the Fresno State College. The nature study program at this institution has received the hearty support of the college president, Frank W. Thomas. The faculty of this institution has proposed the development of a Handbook on the Natural and Human Resources of the San Joaquin Valley. The San Joaquin Valley, which is the southern portion of the Great Central Valley, and measures, excluding the foothills and mountains, approximately two hundred fifty miles long by seventy-five miles wide, is the area served by the College. Outlines for the handbook deal with the following topics: Geography; Geology; Original Inhabitants—the Indians; San Joaquin Valley History; Agriculture, the Basic Industry; Oil and Hydroelectric Development; the Flora and Fauna; and Federal and State Parks and Forests. Each topic is to be developed in a popular fashion with emphasis on educational values, is to be well illustrated, and is to include an adequate list of selected references from which the teacher or general citizen may gain much additional information.

Because of heavy teaching loads and the high cost of preparing such an extensive well-illustrated manuscript involving much original work, it has been necessary to seek financial aid for preparing the material for publication. The State Director of Education and the California State Chamber of Commerce have endorsed the project, recommending that the State Centennial Commission favor the project and that funds to prepare the volume on the San Joaquin Valley be provided in the budget for the 1950 Centennial Celebration. They have further urged that other authors be found and funds provided to

prepare four additional volumes covering the remaining areas of the State. Action on these recommendations is now pending. The California State Curriculum Commission has already indicated its interest in the material for distribution among California schools. Funds for publishing these materials would come from the California state Textbook Fund. If funds for the preparation of the material are not included in the budget of the California Centennial Commission, it may be necessary to raise the funds through local subscription.

It may be gathered from the preceding portion of this discussion that California is aware of the need for nature and conservation education. One should not conclude that since efforts are being made to solve our problems, that solutions to date have been adequate. California is still faced with some very serious problems. The population of this state is three times as great today as it was in 1920. The middle thirties brought the migration from the Dust Bowl particularly to the agricultural areas of the Great Central Valley. Literally, masses of people migrated to California to participate in the war effort and many of these have remained. Recent statistics indicate that the States of Oregon, Washington, and California have added 3,800,000 new residents since 1940. This represents an increase of 2,968,613 or 43% for California since 1940. The population of Illinois, New York, and Pennsylvania has increased less than 5% during the same period. The character of the population in California has also changed. A large proportion of recent immigrants fall into the class of younger people, and while they continue to come, the population is already showing the effect of a higher birth rate.

Race problems, too, are a part of this change. In 1940, 95.5% of the California population was white, 1.8% negro and 2.7% other races, principally Japanese and Chinese. The increase in negro population since that date is startling. The negro population of Fresno has increased approximately 300% and comparable increases in the negro population have occurred in other metropolitan areas of the state.

Educational problems are further aggravated by the great migratory population which moves about the state following the various crops—fruit, cotton, and vegetables. This population numbers about 25,000 workers who normally have large families. As a result, the pupil turnover in rural schools is almost unbelievable.

The increase in population, coupled with a reduction in number of teacher training students in the several colleges and universities of the state, lead to a serious teacher shortage. This shortage still obtains, although a constitutional amendment providing a minimum of $2400 per year for the elementary school teachers resulted in a shift of large numbers of out-of-state teachers to California. Fresno County

has at present 40% of its elementary teachers operating on emergency credentials. For the San Joaquin Valley as a whole there was an increase from 25.6% emergency teachers in December, 1946, to 28.8% in November, 1947. Active recruitment of teacher training candidates is now underway.

The key to good teaching is a well-trained teacher, and this constitutes a major problem in California as well as elsewhere throughout the United States. Obviously, the problem of in-service training is at the fore. There is need for greater offerings in extension classes, summer sessions, workshops, radio programs, and in specific printed materials. Some of the best work that has been performed in assisting inservice teachers has been evolved through extension classes in connection with which teachers were required to conduct science units in their own classrooms, where both teacher in service and college teacher shared through personal visitation and supervision of actual classroom situations.

I believe that a great contribution remains to be made in the improvement of our present teacher-training programs. Certainly the present programs are far from adequate. They need thorough overhauling. Many deans of education, directors of teacher training, and supervisors of teacher-training students have yet to gain a sympathetic attitude towards this field. Their own science backgrounds are often poorly developed and their points of view restricted. In American schools so much emphasis is placed on the development of limited skills that inadequate attention is given to the development of fundamental attitudes and overt behavior. Nor are the science teachers blameless. Their viewpoints are often limited by the walls of their classrooms and the borders of their subjects. Administrators are frequently short-sighted. Science instructors, engaged to train prospective elementary teachers, have little understanding or regard for the tasks of elementary school teachers and possess little understanding of child psychology. Ph.D's attained through work on the embryology of fleas or cockroaches, or on the parasites of the left-hind leg of a red-legged frog, are not likely to prove the best instructors of those who are to be our future teachers of nature study and conservation. Equally serious is the selection of Ph.D's or Ed.D's grounded in educational methods but lacking adequate contact with the basic sciences. If teacher-training programs are to function properly, they should be taught by men or women well-grounded in the basic sciences and familiar with the problems of the elementary school teacher. For such service I would heartily recommend that a college teacher have early experience as an elementary school teacher.

The elementary teacher should receive adequate training in both physical and biological sciences. I doubt that this can be achieved in

less than twelve units in addition to a methods course on the upper division level. Science units in themselves are not adequate guarantees of proper training. It is the selection and presentation of the science experiences in teacher-training curricula that should be subjected to critical examination. These should be such as to provide the teacher-training candidate adequate opportunity to develop scientific attitudes and to establish a scientific habit. In addition there should be greater coordination between the elementary science experiences and the professional observation and participation programs. Guidance by a teacher-training supervisor grounded in social science and not in natural science is the common thing in California. There is need that the professional methods course in teaching of nature study and conservation be given by a science staff member who continues to maintain contact with the teacher-training students throughout their observation and participation courses. This supervisor should maintain close contact with the public schools. It is not easy to pose as an authority when dealing with elementary school children.

In spite of the fact that the California State Department of Education has taken an active interest in the development of nature and conservation programs and that there is a current awareness of and interest in the general problem throughout California, it is also true that science in many California Schools is not regarded as a fundamental subject, and that current outlines frequently outrun current practices. Someone has termed the California system of education the cafeteria system. Select any unit you wish and teach it. A cafeteria may be a good place to get a meal providing one has knowledge of what constitutes an adequate diet. It is possible to do an excellent job of science teaching with social science as a basis if sufficient experiences are provided to make social concepts tenable. From the viewpoint of the science instructor, a study of Australia may be basically sound in California, provided the introduced Australian plants are identified; the Australian animals in the local zoos noted; and the weather conditions compared in the respective areas.

As I look back over the years and view the present status of nature study and conservation education in California, I am reminded of the incident in Walden related by Thoreau of the traveler who asked the lad if the swampy land before him had a bottom. The lad replied that it had. Presently the traveler's horse sank in up to his girths, and the traveler observed, "I thought you said that this bog had a hard bottom." "So it has," answered the latter, "but you have not half got to it yet." There is much yet to be done to get nature study and conservation education functioning properly throughout California. Nature study, as I understand it, is the natural study of the natural environ-

ment. It is the expression of a point of view so ably supported by Jackman, Jordan and Bailey.

Within the last twenty-five years great emphasis has been placed on the teaching of generalizations even in the lower levels of the elementary schools. Scientists know that broad generalizations may be made only with the greatest caution and at considerable risk. Such concepts are rarely attained as a result of limited experience with natural phenomena. Some elementary science leaders have stressed their use to the point that their students are actually having children learn generalizations by rote and repeat them as platitudes.

Other elementary science leaders also demonstrate their unfamiliarity with the scientific method or their failure to practice the scientific habit by making such recommendations as the following: "The excursions have limitations as a means of getting at the truth about phenomena. Unless a person is truly expert in a subject he may observe a phenomenon and come to the wrong conclusion. In the end, conclusions arrived at through excursions should be checked by authentic books prepared for children." And further . . . "In science we are eventually dependent on authority, one who makes a special study in a field. We are dependent upon ornithologists for information about stars and other heavenly bodies, and upon geologists for information about earth forces and phenomena. What these experts tell us is even more trustworthy than what we obesrve for ourselves."

It seems further regrettable to me that distinct cliques exist among educational leaders in the field of science education. The 1947 Yearbook of the National Society for the Study of Education was prepared by a group which failed to present what I view as an adequate picture of nature and conservation education. In it and in its predecessor, the Thirty-first Yearbook of the same society, the authors have presented a distorted notion of nature education in America. I believe that they have demonstrated either bias or ignorance of the fundamental soundness of the representative nature study philosophies that have been expressed by the great leaders in American nature study.

The fundamental purpose of science teaching in American elementary and secondary schools will not be achieved by acquiring vicariously the cumulative knowledge of the scientists. Education is a personal matter. It should begin with the child in his immediate environment. The child should be encouraged to use his several senses and to proceed under the guidance of a teacher who will teach him to see in the broadest sense; who will help him to think clearly; who will guide his imagination and assist him in establishing attitudes that will result in his acting wisely.

Conservation, as I understand it, is, at its best, a functional attitude, a way of behaving wisely towards one's natural environment. I doubt that we can legislate functional attitudes effectively. We will move forward farther and faster by improving our educational programs. Sound conservation practices may be immensely furthered by adequate nature study instruction in American public schools.

TRANSFER OF TRAINING

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To me, transfer is not automatic but depends upon a deliberate attempt to interpret new situations in the light of past experience, one might say that if there is to be transfer, there must be teaching for transfer. Rote learning, routine and blind rule-of-thumb procedures, and empty verbalism are not good for transfer but rather meaningful learning and understanding. It is the job of the school to equip the student with the knowledge, skill, and methods of learning necessary for him to apply to the solutions of the new type of problem arising out of his adjustment to society. The purpose of education is to prepare the individual for society, and this means to prepare him to meet situations which will differ in many respects from the educational situation in which the preparation was acquired. This preparation succeeds or fails depending on the ability of the student to transfer training in school to society.

The school can help children to transfer their training by transfer from subject to subject as well as transfer from subject to life situations. The best way to apply transference in mathematics is to take incidents from life situations and build principles in mathematics from these situations. For instance, in a football game all the players must have some agreement of what a touchdown is and what a down is, likewise in mathematics there must be some agreement of what a triangle is and how many degrees in the angles of a triangle. The need and use of decimal fundamentals are brought out by a study of banking. Many other life situations and use of mathematics may be shown as closely related. Give the subject or topic a purpose in life and you will have the student anxious to learn and know that subject.

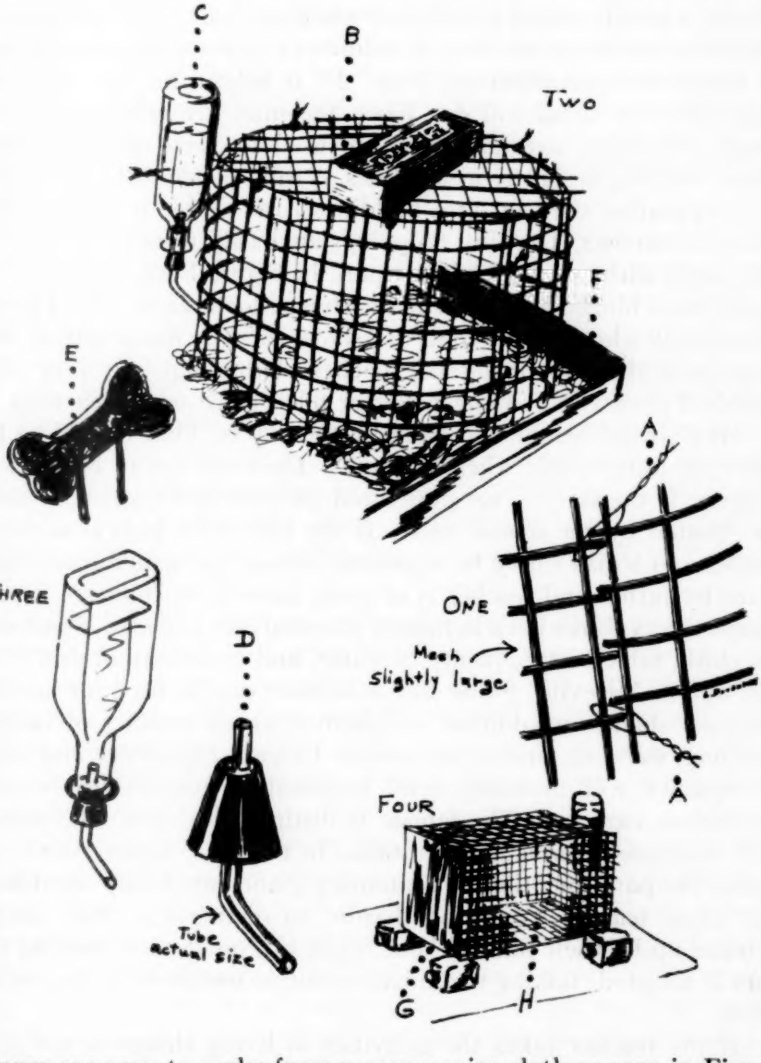
ALUMINIZED STEEL

Aluminized steel of a new type is particularly for anodes and other fabricated parts for vacuum tube use. The material eliminates the need for carbonized nickel-plated steel parts, and, it is claimed, provides better welding properties, lower cost and eliminates possible transfer of carbon to cathode during manufacture.

FROM MICE TO MEN

LEONARD S. DAVENPORT
State Teachers College, Cortland, N. Y.

After shoving and pushing, the group of curious youngsters that crowd about a cage of mice soon accept the tiny animals as a vital part of their classroom. The teacher may well be alert to three easily handled considerations, namely: housing, care, and teaching use.



Cages are easy to make from a coarse wire cloth as seen in Figure One. The cloth wire is cut with snips borrowed from a janitor. The

metal cloth is held in place by a twisted wire—See "A". Figure Two shows a cage made from two pieces of wire cloth. A weight is needed on "B" to keep the mice from escaping and to balance the water supply—"C". Figure Three is made from a common bottle, a rubber stopper (one hole) and a piece of bent glass tubing. Your local high school can provide these items. Be sure to hold the tube with a cloth, wetting tube and stopper prior to the insertion if "D" is to be assembled. Bottle "C", in position, is wired loosely to the cage. Water is free from contamination and runs only when mice lick the tube. The bottle is merely raised and refilled when necessary. "E" shows a dog biscuit wired ready for close attachment to the top of a cage keeping it free from contamination. Tray "F" is helpful but not necessary. Any sheet of metal will do. When the mice are nesting, shredded paper, excelsior, sawdust, etc., are used to keep the mice warm. Some bedding is sightly at all times. A mild deodorant such as C.N. or preparation used in farm buildings is advisable in warm, rather close classrooms. The tiny droppings are easily removed twice daily by pupils with a brush and dust pan. In Figure Four, "G" is a sheet metal door hinged at the bottom with wire loops as in "A". The door closes with a hook at the top. "H" shows the wire mesh bottom of the cage and the supporting ink bottles. Droppings are very easily brushed from the building paper or oiled cloth on which they fall.

Mice should be handled daily by the pupils. They should be kept moving, particularly when on hands. They are apt to nibble warm fingers. If the skin is ever punctured (this rarely happens), it should be treated by the school nurse. If the instructor feels it advisable, males and females may be separated during the school day. Family care by father and mother is of great interest to children. A grand opportunity shows itself in human parental care and love. Small strips of cloth, table scraps, plenty of water, and avoidance of drafts keep all well in Miceville. Some strains of mice can be bred for hundreds of color-shades in addition to inherited characteristics of swaying, circling, waltzing, and lethal factors. Colgate University and science companies will probably send information relative to breeding, nutrition, care, etc. The female is distinguished from the male by the closeness of anus and genitalia. In the male about $\frac{1}{4}$ inch separates the parts mentioned. Mammary glands are easily identified in an adult female. Young are harder to distinguish. Mice may be picked up by their tails without fright if a quiet, slow-moving manner is adopted; talking to animals is not so foolish as it may seem at first.

If the teacher takes the activities of living things in her stride, eagerly learning every day—so will the children. Many parents are deeply grateful for schools maintaining a balanced world and en-

hancing the sweetness of father and mother and off-spring as seen in the association in humble laboratory mice.

THE MIL

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In his article "Notes From a Mathematics Classroom" in the May, 1948, number of SCHOOL SCIENCE AND MATHEMATICS, Mr. Joseph A. Nyberg made the suggestion that someone should write a note concerning the origin of the word "mil" as a unit of angular measurement. The writer of this note was interested in this suggestion because he himself had often wondered whether any historical data might be available. Brief research on this subject brings out the following information.

The word "mil" comes from the Latin "mille" which means one thousand. This same Latin word (but not its meaning) is preserved in our word *mile*. Writer and readers alike may remember from their study of Caesar the expression "*millia passuum*." We have mil as a prefix in the words million, millimeter, and so forth. Recently the first syllable "mil" has been detached for common usage with the meaning one thousand. For example, there is the expression "ox bones per mil." More commonly the word is used in connection with some kind of measurement or value. In Palestine the mil is 1/1000 of the English pound sterling. The word "mil" is also used as a unit in measuring diameters of wires. In this connection it is 1/1000 of an inch.

As stated in many books of trigonometry, mil as an angle measurement is defined to be 1/6400 of 360 degrees, or sometimes it is defined to be a chord subtending an arc which is 1/6400 of the circumference. Hence, the mil is equivalent to $3\frac{3}{8}$ minutes of arc, or a chord whose length is $.98174 \times 1/1000$ of the radius, or almost exactly 1/1000 of a radius. Consequently, one sometimes sees the mil defined as arcsine or arctan .001.

A little known but interesting method of applying the mil in the field is to sight at an object with a finger held up at arms' length. For example, if one wishes to estimate the length of an object whose distance is known, he can close one eye, hold up a finger, and sight on the right and left sides of the finger. For an estimate of the number of mils subtended by the object, at arms' length the finger subtends an angle of approximately five mils, two fingers subtend an angle of 10 mils, and so forth. This gives a basis for an estimate of the size of an object whose distance is known.

THE USE OF INDEX CARDS IN ARRANGING COURSE MATERIAL

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AND
MURIEL BEUSCHLEIN
Parker Elementary School

The system to be described is adaptable to many purposes whether one is teaching a course or studying or enrolled in a subject. It may be used in planning or developing a new course, unit, or part of a unit, and is applicable to various teaching levels as well as spread of content.

Index cards are used universally for bibliographic purposes, but also lend themselves excellently to note taking. For this latter purpose they are a more flexible medium than the ordinary notebook and are more durable as well. For these reasons we have used index cards as a basis for organizing a large subject area with necessary associated material, devices and aids. Such a system of organization is especially effective in science and science methods and may be applied to the teaching of elementary science. Here as elsewhere it is of considerable advantage to the teacher because of convenience and of the time which may be saved.

The need for schemes of orderly arrangement are obvious. With each subject typed on one or both sides of, preferably, 4×6 cards under an appropriate title or heading it may be quickly filed and readily rediscovered. It has been used for quickly locating teaching aids which were filed under many subjects or titles. Science experiments dealing with many phases of the same subject area or with different areas can be easily extracted for a particular teaching period. Reading lists are easily prepared, especially when the grade level has been prominently indicated on the card. Audio-visual aids can be readily assembled if thus cataloged, and subject or content references for the teacher can be collated.

Anticipation of future needs is easy when one builds such file in advance of course or activity expectations. Suggestions from any source, new ideas and possibilities to be examined, unused lists of sources of materials, and notes for ways of improving teaching, all, can be stored against future need and be withdrawn and examined when desired or needed.

Advantages of such a system are numerous. Little space is required for a card file. It is compact, portable, dustproof and inexpensive. The materials and information therein are literally at your finger

tips and are mobile. This ready versatility prevents the lists from becoming static. Materials can be added, removed, relocated, reorganized, reclassified, easily and quickly. Such a plan can be as comprehensive as ambition and alert interest demands. Effective organization of the file relieves one of the necessity for searching through stacks of texts, old notebooks, clippings, or tests for something which is not quite remembered but which might be very useful if only it could be found without too much time spent in hunting.

On what basis does one develop such a file, outline or teaching plan? First, at least a partial awareness of needs is required. This applies especially to elementary grades and grade requirements including supplementary material for enriching or expanding units or experiences. Second, the teacher, or student, must have some knowledge of the innumerable sources of adaptable material. Planning how to broaden the scope and use of these sources is important.

It may be objected that one must have a definite plan of organization or starting point. Begin anywhere—once a small collection is gathered it may be organized as it grows and perhaps reorganized as greater volumes of ideas and materials accumulate. The subjects as listed in the Vertical Index make an excellent basis for classification.

The bibliography portion should include or comprise several phases. Teachers need books, on teaching procedures, including testing methods, and lists of possible activities. The teacher may also have a need for content reading for personal information and would include a list of such books in the file. Needs for children's books are comprehensive. In science these fall under four general headings: reading for pleasure, reading for general information, books for specific subject area reference, and supplementary texts to augment regularly available books. Books to be included in such a bibliography may be located by several means. Book reviews in educational, professional, hobby and trade magazines are good sources. There are reading lists published by municipal libraries, museums, state libraries, state departments of instruction, and by various associations and societies, and graded lists of publishing houses. First hand examinations of books may be made in public libraries and book shops. The bibliography should be keyed or marked to indicate inspected material which has been evaluated and graded. The bibliography should also have a separate section which deals with magazines and newspapers. Among these are those which the teacher may read for enrichment of class room information, including journals from which detailed information is used, and those which are merely read for background. A second group of magazines and papers is those for the children. Of course all bibliographic materials must give address of publishers and cost or subscription price.

Under the subjects listed in the file should be sources of free and inexpensive materials: sources of audio-visual aids which may be separated into such divisions as: pictures for bulletin boards, charts, films, lantern slides and other categories including hectograph books; sources of supplies and actual objects such as seeds, fish, silkworms, plants, for example.

A section of the file contains complete directions for performing simple experiments and demonstrations. Among these are included the old and tried effective ones which the teacher has seen or used, and a new list of those to be attempted, and if satisfactory, added or substituted.

The file of aids is an active reservoir of functional illustrative material, an eternal source from which may be drained a steady flow of inspiration and interest.

Anyone who begins a teaching file will find his enthusiasm growing with the increasing accumulations of valuable helps, and with their successful use in classroom presentations, Further, this interest will be reflected and augmented in the lives and experiences of the children in that classroom.

HALF AMERICA'S ALUMINUM SUPPLY MADE BY COLUMBIA RIVER HYDRO-ELECTRIC POWER

Aluminum supplies to meet American needs rest heavily on the electrical output of the hydroelectric plants operated by waters of the Columbia river at the Bonneville and Grand Coulee dams.

Power from these two relatively new dams constructed by the U.S. government produces about half of the national output of primary aluminum. Dr. Paul J. Raver, Bonneville Power Administrator, told the American Society of Mechanical Engineers.

The Columbia river power development to date has been almost an accident, he said. Dams were authorized and begun primarily as public works projects, but fortunately were completed just in time to make great contributions to America's production of aluminum and other war-needed products.

Today the entire dependable power capacity of both these great dams is being used to the fullest. The reservoir of low cost power to which the nation's electrochemical and metallurgical industries looked has been drained dry.

ACCIDENT FACTS

If you are one of those "two-drinks-don't-hurt me!" guys, here's something to think about:

The 1948 edition of "Accident Facts," statistical yearbook of the National Safety Council, shows that one out of every five drivers involved in fatal motor vehicle accidents in 1947 had been drinking.

Special studies indicate that drivers who indulge in only a few drinks are three or four times more likely to have an accident than those who refrain from drinking if they drive. And drivers who are heavy drinkers are 55 times more likely to have an accident.

The yearbook also points out that one out of every four adult pedestrians killed in traffic accidents last year had been drinking.

MAKING CONCRETE SEVERAL KINDS OF VARIATION IN ALGEBRA

Sheldon S. Myers, *Mathematics Supervisor*
James E. Marks, *Student Teacher*
Jack Reynolds, *Student Teacher*
Western State High School, Kalamazoo, Michigan

In the Duke University Mathematics Institute *Highlights*, the above supervisor listed five devices for making concrete a few of the kinds of variation taught in algebra.[1] In December of 1947 the two student teachers who co-authored this paper launched with enthusiasm the project of constructing these devices and using them in the advanced algebra classes where they were doing their student teaching. The four that were constructed consisted of a single pulley, train of two gears, lever, and two thermometers. The main purpose of the project was to promote understanding of variation in the minds of the students by a careful association of the concrete and abstract concepts of variation. It seemed that a good way to accomplish this purpose was by means of mechanical devices, each of which exhibited by means of visible movements a particular type of variation. Other related purposes of considerable importance were: 1. to motivate and stimulate pupil interest, 2. to contrast the deductive and inductive methods of mathematics and science, respectively.

With regard to the last purpose, we know that, on the one hand, mathematics involves deductive reasoning from assumed premises to specific conclusions and exact science, on the other hand, involves the experimental determination of specific facts and the inductive reasoning from these facts to generalizations in the form of theories, laws or principles. In view of the existence of these two methods, it seems advisable to make at least some attempt to demonstrate even in high school the difference between these two approaches and to show how mathematics can be a valuable tool in the inductive process. In fact one can point out that mathematics is frequently indispensable in revealing how two variables are related in a scientific problem.[2] The procedure in bringing out the difference between these two approaches will be explained after the first device is described.

Several plans for using the devices in the classroom were considered before it was decided to employ a kind of experimental write-up sheet. This would serve to organize and systematize for the student his study of a device and the variation it exhibits. One might argue

[1] "Highlights," Mathematics Institute, Duke University, Durham, Noth Carolina, 1947, pp. 99–100.

[2] The method of "mathematical induction" is a purely demonstrative method. See Cohen, Morris R. and Nagel, Ernest, *An Introduction to Logic and Scientific Method*, New York, Harcourt, Brace and Company, 1934, page 147.

that good pedagogy would require that the student do his own organizing. However, we know that youth are not born with this ability and that one must start somewhere to set the pattern. We know, also, that write-up sheets are necessary and are used effectively even on the college level. As later proved to be the fact, the printed form fostered neat and careful work on the part of the student. Following is a copy of this write-up sheet:

EXPERIMENT IN VARIATION

Name........................

Purpose

General purpose:

1. Manipulate each of the four devices
2. Record the change in the variables involved
3. Draw the graph relating each variable
4. Express one variable as an algebraic function of the other
5. Name the type of function given above

Specific purpose: (Restate the above using specific names for the device and variables.)

....

....

....

....

Equipment (Make a neat drawing and label all parts.)

Procedure (Describe what was done with the apparatus in gathering the data.)

....

....

....

....

....

....

Presentation of data

Record of data:

Graph of variables: (Construct on attached graph paper.)
Algebraic equation relating the variables:

....

Name of the type of function (Refer to text on variation and conic sections.)

....

We shall now describe the devices and the manner in which they were used in the classroom. The first one studied was the pulley, showing arithmetic complement (inverse linear function). This device consists of a light green, three-inch pulley mounted on a dark blue masonite board one and one-half feet wide and three feet long. Over the pulley is a cord with red weights on both ends. Between these weights on the board is a scale in light green to measure the height of each weight from the bottom of the scale. These colors were chosen to emphasize the moving parts representing the variables and to make the device bright and attractive. The heights of each weight from the bottom are labeled "X" (on the left) and "Y" (on the right). These two distances represent the two interdependent variables to be studied. When X equals Y, the weights are both at five units. When X increases, Y decreases correspondingly so that their sum is always ten.

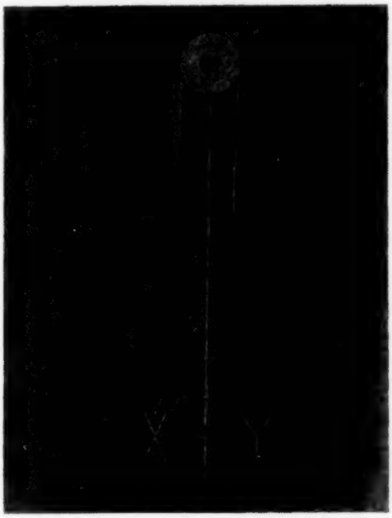


FIG. 1. Single pulley for demonstrating inverse linear variation.

The teacher and the class read through the write-up sheet for the first time together. The purposes discussed earlier in this paper were pointed out to the students in addition to the ones printed on the write-up sheet. When methods of procedure were clear, the students took over. While one held the device, another moved the weights up and down and read the values of X and Y to the class who recorded the data in the box on the write-up sheet. After about eight readings, each student plotted the data on graph paper stapled to the write-up sheet. Following is the graph obtained:

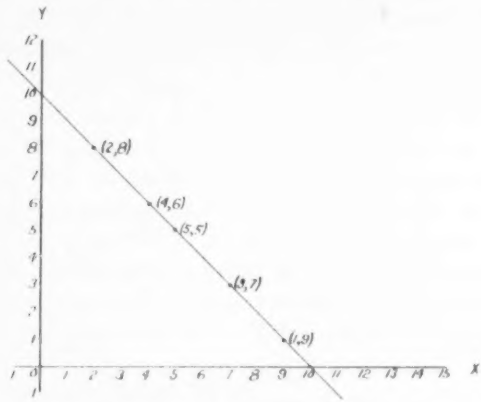


FIG. 2. Graph of pulley data showing an inverse linear function.

Using the slope-intercept form, the slope and intercept were determined from the graph and the equation relating X and Y was derived: $Y=-X+10$ or $X+Y=10$ by transposition. Several sets of data were then substituted to check whether the equation consistently described the relationship. Finally, the students described the variation as an inverse linear function.

At this point the students were asked to compare the method of establishing a conclusion in the form of a proposition in plane geometry with the method of establishing the conclusion in this problem, i.e. the above equation. The words "induction" and "deduction" were defined and applied to these two methods. It was found that the former always involves experimentation and the "law of the great number" (generalizing from a finite number of cases to all cases), while the latter involves premises assumed without proof and complete generality. Of course the students did not express these differences in the technical language used here.

Now that the class had gotten familiar with the procedure on the simplest of the four devices, the train of two gears was then studied. In this case, X represented the number of turns of the large gear, while the small gear was making Y turns. The large gear (light green) contains 35 teeth and the small gear (bright red) contains 18 teeth. To arouse interest, the class was asked how many times the large gear would have to turn around before the painted marks on both gears would line up again. Volunteers turned the large gear once and found that the marks were displaced by one gear tooth. Immediately they began counting the number of teeth in the small gear and announced that it would take 18 turns to re-align the marks, if the large gear were turned continually the same way. There was no little speculation as to why the two gears should have such peculiar ratios. The class

was informed that the gears were found in an old junk yard and may have been a part of some farm machine. One student suggested that the ratios may have been used to diminish wear, since the same parts of both gears came together less frequently than if the numbers of teeth in both gears had a common factor between them.

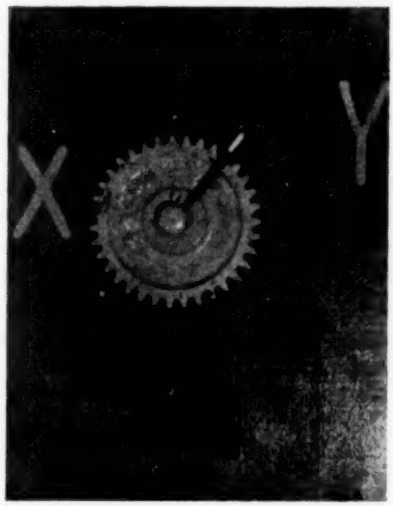


FIG. 3. Train of gears for demonstrating direct linear variation.

With their experience on the first device, the students easily collected data on the two gears, using whole turns for the large gear and

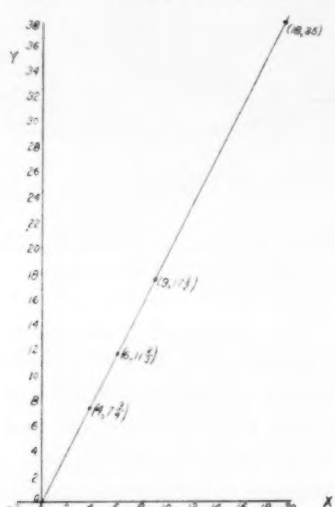


FIG. 4. Graph of gear data showing a direct linear function.

fractions of turns for the small gear. The accompanying graph shows that the curve passes through the origin, making the Y-intercept zero. The slope can be found from the graph to be 35/18, so that the linear equation relating the variables must be: $Y = 35/18\ X$. By converting this equation to the form: $Y/X = 35/18$, it can be seen that the ratio of the turns is inversely related to the teeth.

Following the train of two gears, the class turned their attention to the lever. Much thought had been given in the design of the lever to associate, as closely as possible, the variables (weight and lever length) with the ordinate and abscissa on the graph. By inspection of the photograph it can easily be seen how the abscissa was made to represent the distances of the variable weight from the fulcrum at the origin. In order to make the ordinate represent the weights, it was decided to make the weights from metal rods, one-half inch in diameter. A small hole was drilled close to one end for hanging on a metal hook over the lever arm. Since the diameters were constant, the lengths of the rods were proportional to their weights. Thus, when a particular weight was balanced on the right of the fulcrum, it could be removed from its hook, placed upright on the abscissa where it balanced, and its vertical height plotted as an ordinate distance equivalent to its weight.

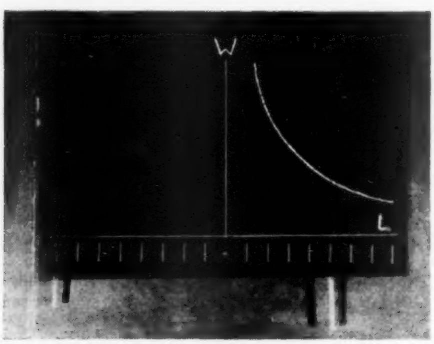


FIG. 5. Model lever for demonstrating hyperbolic variation with accompanying graph.

A pair of students first balanced three-inch weights on opposite ends of the lever arm, which was painted red with light green stripes for lever distances. Brown wrapping paper, cut in a rectangle, had been fastened with scotch tape to the right and above the fulcrum. This paper, embraced by the weight ordinate and length abscissa, represents the first quadrant, which is the only one used for this function. The first point was plotted on the far right, three inches above the abscissa. The data was also given to the class for each of six dif-

ferent weights (all longer than the first) as they were successively balanced and their lengths measured. The curve obtained from these data can be seen in the accompanying photograph.

By searching in the portion of their textbooks on conic sections, the students eventually found that their curve was the positive portion of an hyperbola, with symmetry about the line: $Y=X$. Its algebraic form is $XY=C$, or $WL=C$. The law of the lever could also be derived by varying the weight on the left of the fulcrum. Some students described the relationship of the variables as an inverse proportion;

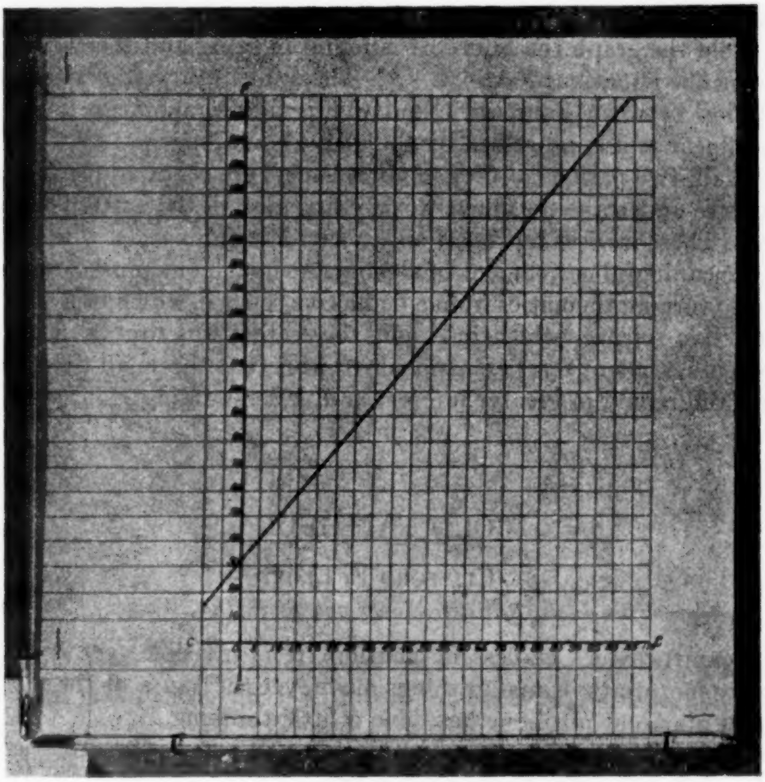


FIG. 6. Correlation of Centigrade and Fahrenheit temperatures.

others called it hyperbolic. A contrast was made between the type of inverse relation exhibited here and the type demonstrated by the pulley.

The final function studied was the Centigrade-Fahrenheit relation. As shown in the photograph, the device depicting this relation achieves the most intimate correlation between the actual variables and the coordinates on the graph. The ordinate thermometer meas-

ured Fahrenheit temperatures and the abscissa thermometer measured Centigrade temperatures. These thermometers were fastened with elastic rubber to the axes and the coordinate lines drawn from their degree markings. Points are plotted on the graph from the ends of the mercury on the two thermometers. The backing was made of heavy cardboard with the lower left corner cut off diagonally so that the bulbs of the thermometers could be dipped in water of various temperatures. These temperatures enabled the students to obtain data for plotting several points, both on the coordinate grid system of the device itself, which is the most ideal situation, and also on their own graph paper.

From the graph the intercept is found to be 32 and the slope 9/5, giving the equation: $F=9/5C+32$. The student now states that the relation between Fahrenheit and Centigrade temperature is direct and linear and is expressed by the above equation.

In all, two periods of fifty minutes each were required for the students to undertake the above work, doing most of the written work in class. These devices represent only a small beginning in a worthwhile and meaningful enrichment of algebra. Although one must be careful not to turn mathematics from a deductive science, which it is, into an inductive science, which it is not, the feeling was mutual amongst students, student teachers, and supervisor, that the small time spent was well repaid in greater interest and understanding.

OLD FAITHFUL

Clifford E. Lloyd

Development Engineer, Pellissier, Jonas and Rivet, Inc., Walden, New York

Steam provides endless fascination. It is invisible, yet it leaves heavy footprints. It makes things move, yet the cause of the motion is not apparent until one has done a little thinking.

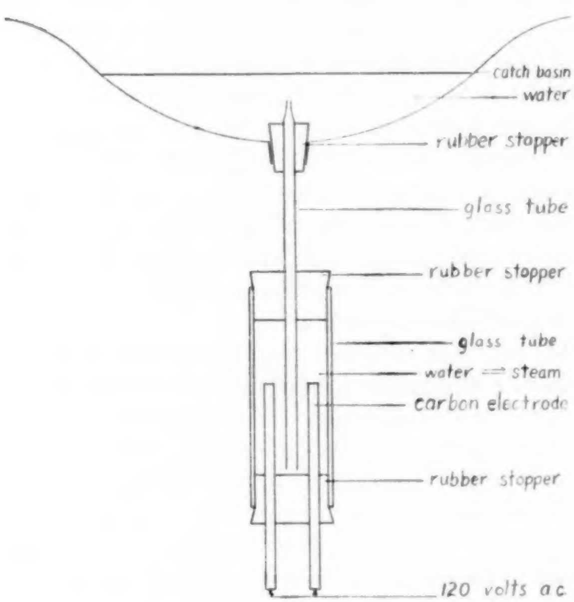
Old Faithful features steam and motion. It arrests the attention of all and develops the thinking of many.

As shown in the diagram it consists of an electric water boiler and a catch basin. The boiler is a large glass tube. Carbon electrodes enter through a two hole stopper at the bottom and the squirt tube passes through a one hole stopper at the top. The squirt tube enters the bottom of the catch basin. The jet on its end must not be too fine or the pressure in the boiler will blow out the stoppers. The catch basin may be made of cement plastered on screen wire.

The boiler is heated by 120 volt house current. Wires are very nicely held on the carbons with short pieces of rubber tubing.

In making the geyser—first grasp the fundamental principles and then reconstruct it using the junk which you happen to have at hand. At the start the boiler is filled with water. The current passes through the water and gradually heats it to boiling. The steam pressure developed drives the water out of the squirt tube into the catch basin. If it is too slow put a pinch of salt in the water. When the boiler is empty of water and full of steam the current stops. The steam cools

SECTION OF GEYSER



and condenses. The pressure drops and the water in the catch basin is pushed down through the jet into the boiler again. The jet must be covered with a half inch or more of water, or air will go down with the water.

This device provides a very fascinating means of learning some of the properties of steam. That it has some of the characteristics of a geyser is incidental.

RIBBONWRITER

Ribbonwriter, an attachment for standard typewiters by means of which from one to five copies may be made without the use of carbon paper, produces letters all of which look like originals. The ribbons of the easy-to-attach and easy-to-use device outlast ordinary ribbons two to one because cushioned from sharp keys by paper.

THE CASE FOR METHODS COURSES IN MODERN TEACHER TRAINING

G. D. McGRATH
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Perhaps the most disputed aspect of teacher education is the role of methods in adequate preparation for efficient classroom teaching. The case for methods is unalterably unassailable in the minds of those who really know what good methods courses have to offer. These proponents realize that proper methods work is an inescapable requirement in a well woven pattern of related experiences all teacher trainees should have. It matters little whether one subscribes to a modern common learnings-general education program, or to a more traditional program of secondary education—the proper blend of good methodology as a series of techniques, can be discarded only at a definite diminution of instructional excellence. The methods enthusiast is not a super progressive with both feet firmly planted in the air, but one who believes in a movement which he knows to be superior to methods-barren alternatives.

The writer has just completed an analysis of approximately one hundred teacher education programs in carefully selected teacher training institutions. In addition, the syllabi or courses of study were obtained for the methods courses offered.in about fifty of the original group of one hundred. Certain pertinent findings are offered for general reflection before the case for methods is presented.

1. There is an unmistakeable tendency to re-name methods courses to escape a certain stigma attached to them. Operating under a different title, the courses are often admittedly nothing essentially different than former courses offered under titles such as "methods of teaching in secondary schools."
2. Of over one hundred schools included in the study, 89 percent offer at least one course dealing with the content of general methods of teaching. Sixty-one (61) percent of the total require this course in the pre-service training program.
3. The objectives stated are surprisingly similar—principally dealing with improved classroom instruction via better methods of organization and presentation.
4. A wide variety of techniques is used in methods courses, with heavy emphasis on the lecture-discussion form of organization.
5. A prerequisite of at least three quarter hours of education is required by 91 percent of the schools requiring methods, while six percent require at least 6 quarter hours of course credit in education as a prerequisite.

6. Where the course in methods is required, it serves as a prerequisite to student teaching or another education course in 96 percent of the cases.
7. In 51 percent of the cases requiring methods, they are required in the junior year; 42 percent offer them concurrently with student teaching in the senior year.
8. The methods course consists of three quarter hours in 66 percent of the cases, while four quarter hours are offered in 18 percent of the cases. Others offer five, six, eight or two quarter hours.
9. The course of methods was stated to be under re-organization in 88 percent of the cases and tangible evidence of the reconsideration given was submitted.
10. Twenty-eight different textbooks were used for methods courses with an extremely wide selection of additional reference readings indicated.

One interesting sidelight on the contribution and importance of methods comes from studies summarizing opinions of teachers in the field regarding effectiveness of their pre-service preparation. In a great number of such studies, methods were given the number one or most important rating. In all of such studies which have come to the attention of the writer, methods were rated among the three most important areas of training.

Here, then, is presented to us a strange paradox. Teachers rate methods courses as highly important and many training institutions are still requiring such courses, but educators, in general, are associating a certain hesitancy with methods, and are re-naming the content under disguising names. Too, many instructors of methods appear to be constantly on the defensive as to the values and contributions of such courses in the total pattern of teacher training.

An examination of some of the weaknesses and limitations of methods courses, as often given, may clarify the ostrich-head-in-the-sand reaction.

1. The battle between subject matter academicians and methods enthusiasts has never waned. It is usually conceded that one cannot teach what he does not know, thus enhancing the position of the academicians. Each group has maneuvered against the other for a larger portion of the required hours of training, never realistically considering a proper blend of the two.
2. Many methods courses became a cook book approach to teaching with a formalistic stereotyped treatment of the problems confronting the teacher in the classroom. Teaching, thereby, became largely a matter of selecting the proper technique out of a well organized bag of tricks. Such procedures

lessened creativeness and ingenuity and developed an apathetic personality in many teachers.

3. Good methods courses are difficult to prepare. It takes years of hard work to build abundant helps and materials from researches, reports in the literature, successful techniques of master teachers, and other sources. Not many people, relatively speaking, have taken the trouble to really construct worthwhile methods courses and thus the work is often diluted by informal chit-chat. Many so-called methods courses were never planned as methods courses, but as credit bearers only.
4. The movements toward general education, core curriculum, and common learnings came along. Methods courses, in their older form, were accused, perhaps justly, of building up subject matter entities for the specific subject's sake, with a resulting barrier for participation in common learnings situations. Good methods courses actually implement common learnings by widening the applications of subject matter for broader participation in these essential common learnings. For the most part, methods were organized solely to improve subject matter courses. Methods can materially implement the success of strong subject matter courses when such courses are provided only for those who should take them.
5. It is somewhat ironic that certification requirements have often worked against good methods courses, while at the same time prescribing them. Often, a certain number of hours in methods were required, but many training institutions did not wish to offer them or had no staff members willing to undertake organization of a methods course. Educators can well recall situations where an instructor assigned to methods vehemently stated at the outset of the course that it was to be called methods for credit purposes, but that there was no intention of discussing such a horrible ghost as methods.
6. A struggle over who offers methods work still exists in many institutions. It is natural in conflict or duress for opposing parties to cling tenaciously to their own premises. Thus, the subject matter specialists insist on offering the course in methods, in which case, it normally becomes merely more subject matter. Conversely, when education departments insist on their perquisites, they are accused of mass sugar coating of subject matter for presentation, to the end that it becomes an impractical hodge-podge of general information.
7. We have too much to accomplish in the four years of time usually provided for pre-service training. As will be shown later

in this report, if all the materials properly suited for methods were included, it would require a minimum of nine quarter hours, whereas we find most curricula hard pressed to allow three quarter hours for such work. Some items will have to be deleted or the length of pre-service education must be extended beyond four years. It is so very easy to omit methods by assuming that the teacher will pick up all of those things when actually in the classroom, even though by way of bitter experience.

8. One of the strange anachronisms of the problem for methods is that many of our older teachers never had a good course in methods and thus do not believe good ones can exist. We are quite prone to teach as we have been taught, so these people quite logically stress courses which they have taken. Many of the instructors so adamantly opposed to methods courses are themselves the worst teachers.
9. We have had too little research in methods of organization and instruction to be certain of some of our premises. While this is not a valid argument for casting out all methods, it, nevertheless, seriously hampers the effectiveness of such courses. However, lack of real meaningful research likewise impedes all other areas of education and the picture for methods is not especially disheartening. Parallel with this dilemma is the fact that thousands of successful practitioners of education have not contributed reports of outstandingly successful techniques to the literature for colleagues to share and profit therefrom. We need to tap that vast reservoir of significant improvements in techniques held in the minds of great teachers.
10. Methods courses have too often been offered as a theory course, quite divorced and apart from actual practice. Good methods courses should involve actual participation with children, preferably as a pre-student-teaching experience, or concurrently with student teaching. Theory and practice have to be interrelated through observation, demonstration, participation and research if either is to be significantly worthwhile.
11. At one point in our development of teacher preparation, methods were over-emphasized. This was especially true in some teachers colleges. Almost always, when the pendulum swings to an extreme, progress in its cycle stops and it reverts or perhaps even retraces its pathway to an opposite trend. Such has been true of methods work. Until such time as we are able to define the tasks of a teacher more explicitly, and until we have a suitable framework for suggesting what today's and tomor-

row's schools should be like, the pendulum will continue to swing from one extreme to another, perhaps with erratic tendencies.

12. Adequate facilities to offer functional methods require tremendous expenditures and abundant materials. It has been impossible to set up sufficient equipment and environment for methods in all but a very few cases, thus, widespread offering of real methods has never been tried. No one can state accurately the success of something on which there has not been reasonable venture. Educators know, however, that providing certain types of training and experience should produce a certain type of teacher and that methods can form an integral part of the experiences which will guarantee the best type of teacher.
13. Many less important items have contributed to the confusion regarding the importance of methods and may logically be listed under one heading:
    a. Too many have returned to the teaching field after long periods of absence via a methods-refresher course. This tends to generate considerable scorn for the course by others.
    b. Good methods courses have too often been postponed to the graduate study program, encouraging one to learn the techniques methods should supply through trial and error and headaches.
    c. Heavy election of methods courses often earmarks one for classroom teaching, while in the thinking of the trainee is the eternal hope to go into administration where the money is. Apparently we have never sufficiently stressed the fact that good administrators should first have a thorough knowledge of successful classroom instruction and methodology.
    d. We have failed to listen to the suggestions of our graduates in the field. Investigations have shown very little follow-up and service for our graduates to help them after they leave our traditioned halls of learning.

At this point, we have castigated methods sufficiently and should turn our attention quickly to constructive issues.

It is expressly stated that outstanding methods courses do exist and have been taught and from them can be learned much to assist us in planning for better ones in the future. To that end, certain assumptions are hereby postulated:

1. Methods in general center around three divisions: general methods, field methods, and special methods. General methods deal with a basic platform for general classroom participation, treat-

ing such topics as the art of questioning, general advantages and limitations of various contract plans, etc. Field methods deal with methodology especially suitable for areas such as science, social studies, etc. Special methods deal with subjects, typically illustrated by methods of teaching biology. Later, suitable topics will be suggested for each of these three divisions.

2. Methods are justifiable only if they implement the principles of education which are compatible with a wholesome philosophy of education. Such principles stress the social implications and theory of human engineering for education. Methods are the techniques by which we put into practice sound principles of education.
3. Each curriculum must select for itself the type and amount of methods it feels will equip teachers best for meeting education's responsibility in the world today. No one pattern will suffice uniformly.
4. Every weakness listed in the foregoing pages of this report can be circumvented through careful planning and logical attack.
5. We have an abundance of excellent textbooks available to implement good courses in methods. In addition, there are many excellent prospective texts in preparation to come on the market relatively soon.
6. Methods must be closely related to student teaching. The two must be vitally interrelated.
7. The need for methods should be made clearly discernible by a course of principles of education wherein the social implications for education are set forth. When an awareness of the social responsibilities for education is created, the need for good methods to implement these principles follows inherently.

A few suggestions are offered for consideration of content for each of the three areas mentioned:

General Methods:

The art of directing or conducting discussions
The art of participating in panels and forums
Techniques for making assignments
Instructional planning, the lesson plan
Directing study activities
The problem of discipline
Improving the recitation
The art of questioning
Analyzing and building general aims, objectives, and philosophy
General unit organization
Measurement and evaluation
Personal traits of the teacher
Weaknesses and strong points of contract plans
The socialized recitation
A philosophy for guidance

Provision for individual differences
Audio-visual aids (equipment and operation)
The review—use of textbooks and workbooks
Techniques for the less apt
Evaluation of different types of curriculum for implications for methods
Likely repercussions of the future social scene on methods

Field Methods: (as Methods of Teaching Science)
The mission of the field in education
Problems of the laboratory
Special aims and objectives
Demonstrations, field trips, exhibits, clubs, facilities, equipment, assembly programs, projects
Special evaluation problems
Enrichment materials—audio visual aids, free and inexpensive materials, pamphlets, etc.
Criteria of a well conducted classroom
Reference books for the pupil and teacher
Magazines for the pupil and teacher
Present and future tendencies and trends
Textbook selection criteria
Philosophies and contributions of important leaders in the field
Philosophies and contributions of yearbooks, and associations
Scientific attitudes, principles and method
Practical suggestions for new teachers

Special Methods: (as Teaching of Biology)
A look at better courses of study
Specific objectives
Construction of actual teaching units
Special demonstration techniques
Special enrichment materials
Workshop practice in preparation of materials
Vocational and avocational possibilities in the subject
Implications for the subject in the atomic age
Construction of folios of applications
Organization of basic principles to be taught
Interpretation of technical knowledge for effective secondary school utilization
Refresher in understanding and implications of subject matter

It should be admitted that such lists could go on indefinitely and that it would require at least nine quarter hours of work to cover these areas. Never before in history has the problem of adequate teacher preparation been so important. The teacher is faced with the task of nurturing youth to the end that our young people become proficient in performing the tasks set for them by wholesome and adequate living. If the material we use for developing these youths is to be meaningful and expeditiously mastered, whether via common learnings or specific subject matter in a technical field, we must employ methods as an aid for effectiveness. A new enlightened emphasis on significant methods may well prove to be the most practical tool in helping education meet its great challenge and obligation. No teacher-training curricula can afford to ignore the contributions of methods, and they can select defensible content from methods for

implementing teacher training to a realization of adequacy in terms of its objectives. Our trainees are adamant for an improved pre-service curriculum, and a good course in methods offers perhaps the greatest potential bailiwick for meaningful experiences within the grasp of the educator.

STAR MAPS FOR A CONSTELLATION LANTERN

Sister M. Ignatia
Marygrove College, Detroit, Michigan

Descriptive astronomy, whether it is taught as a separate college course or as a part of a high school course in General Science, has a peculiar fascination for all students, and that fascination is increased when visual aids are used in presenting the subject matter. A set of clay models of the planets, for example, not only serves to make concrete the relative size and distance of each planet from the sun, but also arouses a special interest in these members of our solar system. A small celestial globe that reproduces in miniature the stars and constellations visible to the naked eye, can be used effectively to demonstrate such details as why the Big Dipper, as seen from the northern part of the United States, never sets, and why the Southern Cross cannot be seen north of latitude 34°.

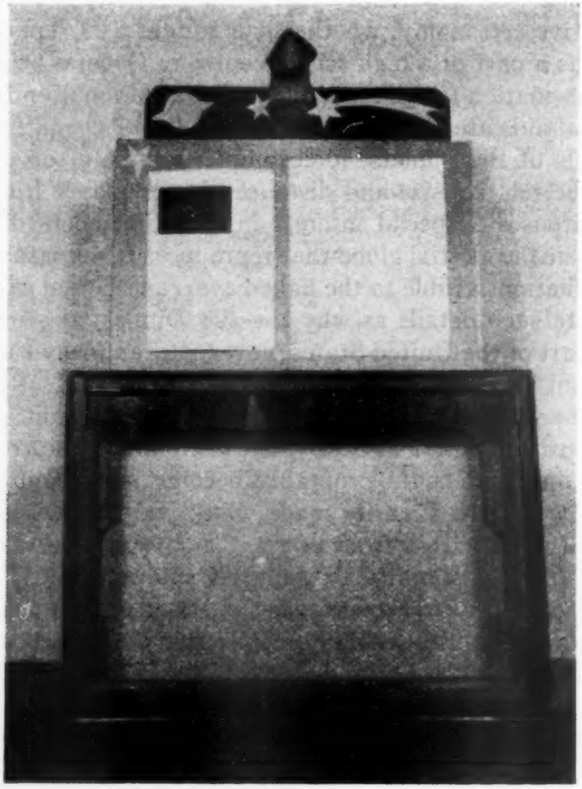
Of the many visual aids that can be used with profit in teaching and in arousing interest in descriptive astronomy, the constellation lantern is one that could profitably become more common in the schools. The lantern is easily made. One type consists merely of a large wooden box with a front of glass, a slit and grooves to hold a cardboard star map parallel to the glass, and an electric light bulb behind the map. A convenient size for the glass front is 14 by 21 inches, and the lighting effects are pleasing if the box is about 20 inches long and has the slit and grooves 7 inches back from the glass front.

Star maps for such a constellation lantern represent the stars by holes of various sizes through which light shines. The following steps may prove useful to inexperienced map makers.

1. Obtain an adequate supply of light weight cardboard and cut it to fit the lantern. Gray is a good color and six ply beveridge board has a convenient weight.
2. Cut a number of sheets of brown wrapping paper (or of any other thin paper) the same size as the cardboard.
3. Choose a pair of constellations adjacent to each other in the sky, and mark accurately the positions of their stars by dots on the brown paper. Sketch in the connecting lines as shown in a typi-

cal star map. See Barton and Barton's *A Guide to the Constellations*[1] or Duncan's *Astronomy*.[2]

4. Note the magnitude of each star by an integer placed next to the dot which represents it.
5. Put the brown paper on the cardboard so that the constellations are symmetrically placed with respect to the center of the cardboard, and puncture the latter by sticking a pin through both thicknesses. Several layers of thick cardboard cut from cartons will protect the table from damage by pin or cork borer.



Details of the construction of a constellation lantern are shown in this picture. The star map is of Leo, the Lion, and Cancer, the Crab.

6. Use a number four cork borer, which cuts a hole nine millimeters in diameter, to represent the stars of zero magnitude. Be careful to have the pin pricks at the center of the hole. Holes for

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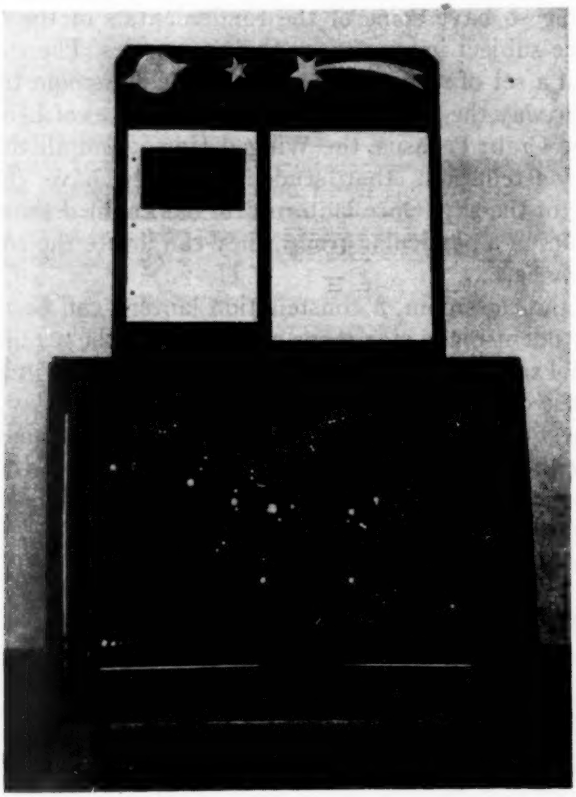
[1] Barton, Samuel G., and William H. *A Guide to the Constellations*. New York: McGraw-Hill. 1944.
[2] Duncan, John Charles. *Astronomy*. New York: Harper and Brothers, 1946.

first, second, and third magnitude stars are cut with the cork borers of increasingly small bore, numbers three, two, and one, respectively. The pin pricks which represent stars of fourth magnitude may be enlarged by the arm of a compass or by some other instrument slightly thicker than a pin. For fifth and sixth magnitude stars, the pin pricks are sufficient. Since the unaided eye cannot detect stars fainter than the sixth magnitude, they should not be included on star maps to be used with a constellation lantern. Before putting away the cork borers, cut a magnitude scale at the lower left hand corner of the map.



Star maps for a constellation lantern represent the stars by holes of various sizes through which light shines. The constellations Andromeda and Pegasus, the Winged Horse, are shown here.

7. Dot the connecting lines on the cardboard with a permanent ink. Dark blue ink on gray cardboard is a pleasing combination. Print the names of the constellations, and in smaller letters, the names of their principal stars. Then label the magnitude scale.

8. Small squares of colored cellophane pasted behind the holes which represent those bright stars whose color can be detected without a telescope, add to the attractiveness of the maps. Antares, Aldebaran, and Betelgeuse, for example, could be red; Capella, yellow; Vega and Rigel, blue.
9. Finally cover all the holes with a large square of dull white tissue paper pasted on the back of the cardboard, and put the star map in the lantern. The tissue paper diffuses the light so that holes near the center are illuminated with but slightly more brilliance than those at the sides.

Students beginning an astronomy class enjoy making these maps and in doing so have some of the fundamentals of the descriptive phase of the subject impressed on their memories. The constellation lantern and a set of maps can be used in the classroom to point out in a realistic way the stars that make up the figures of Leo, the Lion; Cancer, the Crab; Pegasus, the Winged Horse; and all the other interesting constellations that students usually have difficulty in identifying in the sky. Once lantern drill has enabled them to recognize the stars in a particular group, they can locate the constellation with relative ease.

Outside the classroom, a constellation lantern can be used to exhibit the student-made star maps and to direct the attention of the entire school toward the stars. If the lantern is placed in a darkened section of the corridor and the star map changed each day, it will become a center of attraction between class periods. Explanatory material, giving the location of the constellations shown in the map and the pronunciation of all proper names, can be displayed above the lantern, along with drawings taken from a source such as *The National Geographic Magazine*.[3]

[3] Menzel, D. H. "The Heavens Above." *The National Geographic Magazine*, 84 (July 1943), 97–128.

ANCIENT POTTERY SECRETS DISCOVERED BY SCIENTIST

Long-lost formulas used by ancient pottery makers have been reconstructed by Dr. Earle R. Caley of Ohio State College.

Roman pottery fragments found in southern Turkey showed traces of green and yellow glazes. Working with very small quantities of these glazes, one-sixteenth gram of the green and one-fiftieth gram of the yellow, Dr. Caley identified them as lead glazes.

Lead glazing is widely used today on many modern ceramic products, including most dinnerware.

The proportion of lead in the ancient glazes was considerably higher than in modern lead glazes. This fact may be used to distinguish genuine ancient lead-glazed ware from modern forgeries.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

2084. *Hugo Brandt, University of Maryland*

2083. *V. C. Bailey, Evansville, Ind.; Felix John, Ammendale, N. J.*

2085. *Albert F. Gilman, III, Chicago.*

2089. *Proposed by V. C. Bailey, Evansville, Ind.*

Sides of a triangle are a and b equal to 6 and 8 respectively. Find side c if the angle between h_c and m_c is 30°.

Solution by William A. Richards, Riverside, Ill.

There will be two different values for side c as shown in the accompanying figures. In either figure, we have

$$(AM+MH)^2+h_c^2=64 \tag{1}$$

and

$$(BM-MH)^2+h_c^2=36 \tag{2}$$

It is given that $AM=BM=\frac{1}{2}c$. Hence, subtracting (2) from (1), we get

$$2c(MH)=28, \qquad \text{or} \qquad c=\frac{14}{MH}. \tag{3}$$

But

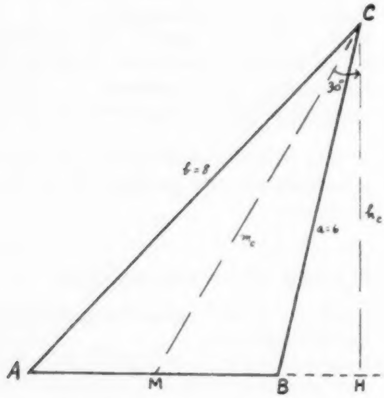
$$MH=h_c \tan 30°=\frac{h_c}{\sqrt{3}} \qquad \text{hence} \qquad c=\frac{14\sqrt{3}}{h_c}. \tag{4}$$

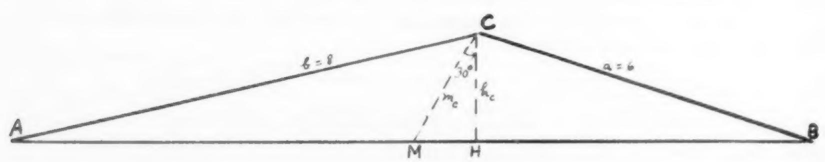
Also

$$h_c=8 \sin A, \text{ then } c=\frac{7\sqrt{3}}{4 \sin A} \qquad \text{or} \qquad \sin A=\frac{7\sqrt{3}}{4c}. \tag{5}$$

And, from the law of cosines,

$$36=64+c^2-16c \cos A \qquad \text{or} \qquad \cos A=\frac{28+c^2}{16c}. \tag{6}$$





Substituting (5) and (6) in the identity $\sin^2 A+\cos^2 A=1$, we obtain, after reducing

$$c^4-200c^2+3136=0. \tag{7}$$

Solving equation (7), $c^2=100\pm\sqrt{6864}=182.849$, or 17.151. Therefore, the two values of c are, approximately,

$$c=\mathbf{13.52}, \qquad \text{and} \qquad c=\mathbf{4.14},$$

Solutions were also offered by Max Beberman, Shanks Village, N. Y.; Margaret Joseph, Milwaukee, Wis.; Alan Wayne, Flushing, L. I., N. Y.; M. Zwicky, Oak Park, Ill.; Felix John, Ammendale, Md.; Aaron Buchman, Buffalo, N. Y.; Norma Sleight, Winnetka, Ill.; C. W. Trigg, Los Angeles.

2090. *Proposed by Hugo Brand, University of Maryland.*

Resolve into factors:

$$5a^4-6ab(2a^2-5ab+2b^2)+5b^4.$$

Solution by C. W. Trigg, Los Angeles City College

Method I.

The expression is symmetrical in a and b, so its factored form must be symmetrical also, say, $(5a^2+xab+b^2)(a^2+xzb+5b^2)$. Equating the coefficients of a^2b^2 in the two forms of the expression, $30=25+1+x^2$, so $x=\pm 2$. Since the negative sign is clearly called for, the factors are $(5a^2-2ab+b^2)(a^2-2ab+5b^2)$.

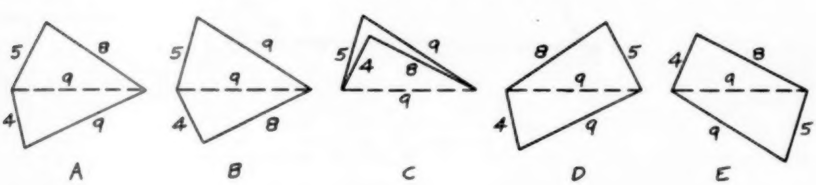
Method II.

$$5a^4-6ab(2a^2-5ab+2b^2)+5b^4$$
$$=5a^4-12a^3b+30a^2b^2-12ab^3+5b^4$$
$$=5a^4+26a^2b^2+5b^4-2ab(6a^2+6b^2)+4a^2b$$
$$=(5a^2+b^2)(a^2+5b^2)-2ab[5a^2+b^2)+(a^2+5b^2)]+4a^2b^2$$
$$=(5a^2-2ab+b^2)(a^2-2ab+5b^2)$$
$$=\tfrac{1}{5}[5a-(1-2i)b][5a-(1+2i)b][a-(1-2i)b][a-(1+2i)b].$$

Solutions were also offered by Norma Sleight, Winnetka, Ill.; Felix John, Ammendale, Md.; M. Zwicky, Oak Park, Ill.; Wm. A. Richards, Riverside, Ill.; Max Beberman, Shanks Village, N. Y.; Alan Wayne, Flushing, L. I., N. Y.

2091. *Proposed by Gloria Dover, Syracuse, New York.*

If the sides of a quadrilateral are 4, 5, 8, 9 and one diagonal is 9, find the area.



Solution by C. W. Trigg, Los Angeles City College

There are only three orders in which the sides of the quadrilateral may be arranged: 4, 5, 8, 9; 4, 5, 9, 8; and 4, 8, 5, 9. Since $4+5=9$ (the length of the diagonal), the three orders allow only four convex quadrilaterals and one concave quadrilateral, as shown in the figure. Of these, A and D have equal areas, since they are composed of congruent triangles. The same may be said of the areas of B and E. The areas have been computed by applying Heron's formula to the constituent triangles.

$$\text{Area } A=\text{Area } D=\sqrt{11\cdot 2\cdot 2\cdot 7}+\sqrt{11\cdot 2\cdot 3\cdot 6}$$
$$=\sqrt{308}+\sqrt{396}=37.44968.$$
$$\text{Area } B=\text{Area } E=\sqrt{\frac{21}{2}\cdot\frac{13}{2}\cdot\frac{5}{2}\cdot\frac{3}{2}}+\sqrt{\frac{23}{2}\cdot\frac{13}{2}\cdot\frac{5}{2}\cdot\frac{5}{2}}$$
$$=\tfrac{1}{4}(\sqrt{4095}+\sqrt{7475})\doteq 37.61257.$$
$$\text{Area } C=\tfrac{1}{4}(\sqrt{7475}-\sqrt{4095})\doteq 5.61647.$$

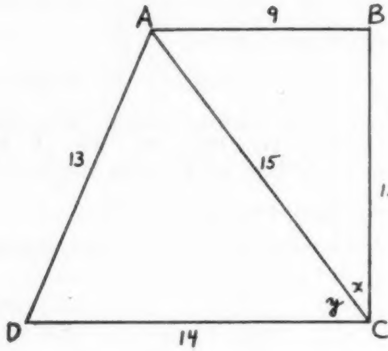
Other solutions: Wm. A. Richards and Max Beberman presented solution for convex polygons A and B. Other solutions for only quadrilateral A were given by Mildred Hopkins, Kankakee, Ill.; Albert F. Gilman III, Chicago; Paul Mount-Campbell, New Mexico Military Institute; Margaret Joseph, Milwaukee, Wis.; M. Zwicky, Oak Park, Ill.; Felix John, Ammendale, Md.; Alen Wayne, Flushing; Norma Sleight, Winnetka, Ill.

2092. *Proposed by Felix John, Ammendale, Md.*

In the quadrilateral $ABCD$, AB, BC, CD, DA, and AC equal 9, 12, 14, 13, and 15 respectively. Find BD.

Solution by Aaron Buchman, Buffalo, N.Y.

A well known formula in the solution of the oblique triangle is that of the tangent of the half-angle in terms of the three sides and the semi-perimeter. From this formula it at once follows that



$$\tan \tfrac{1}{2}x = \sqrt{\frac{3\cdot 6}{18\cdot 9}} = \frac{1}{3},$$

$$\tan \tfrac{1}{2}y = \sqrt{\frac{6\cdot 7}{21\cdot 8}} = \frac{1}{2}.$$

From the double angle formulas, it at once follows that

$$\tan x = 3/4,$$
$$\tan y = 4/3.$$

Therefore x and y are complementary, and angle BCD is a right angle. Then $BD = \sqrt{14^2+12^2} = 2\sqrt{85}$

$$BD = \sqrt{14^2+12^2} = 2\sqrt{85}.$$

Solutions were also offered by Margaret Joseph, Milwaukee; Paul Mount-Campbell, New Mexico Military Institute; Wm. A. Richards, Riverside, Ill.; Max Beberman, Shanks Village, N.Y.; Albert F. Gilman III, Chicago; Norma Sleight, Winnetka, Ill.; M. Zwicky, Oak Park, Ill.; Alan Wayne, Flushing, L.I., N.Y.; C. W. Trigg, Los Angeles; Mildred Hopkins, Kankakee, Ill.; and the proposer.

2093. *Proposed by Charles Reade, Romulus, N. Y.*

Eliminate x, y, z from the equations

$$x^{-1}+y^{-1}+z^{-1}=a^{-1},$$
$$x+y+z=b,$$
$$x^2+y^2+z^2=c^2,$$
$$x^3+y^3+z^3=d^3.$$

Solution by Aaron Buchman, Buffalo, N. Y.

Number the given equations (1), (2), (3), and (4) respectively. From (1) it follows that

$$xy+yz+zx=xyz/a. \qquad (5)$$

From (2) and (3) it follows that

$$(x+y+z)^2-(x^2+y^2+z^2)=b^2-c^2,$$

and therefore

$$2(xy+yz+zx)=b^2-c^2. \qquad (6)$$

From (5) and (6) it follows that

$$xyz=a(b^2-c^2)/2. \qquad (7)$$

From (2), (3), and (4) it follows that

$$(x+y+z)(x^2+y^2+z^2)-(x^3+y^3+z^3)=bc^2-d^3,$$

and therefore

$$xy^2+xz^2+yx^2+yz^2+zx^2+zy^2=bc^2-d^3. \qquad (8)$$

From (2) and (4) it follows that

$$(x+y+z)^3-(x^3+y^3+z^3)=b^3-d^3,$$

and therefore

$$3(xy^2+xz^2+yx^2+yz^2+zx^2+zy^2)+6(xyz)=b^3-d^3. \qquad (9)$$

From (7), (8), and (9) it follows that

$$3(bc^2-d^3)+3a(b^2-c^2)=b^3-d^3.$$

Other solutions were offered by Chas. W. Trigg, Los Angeles; Felix John, Ammendale, Md.; Alan Wayne, Flushing, L.I., N.Y.; Max Beberman, Shanks Village, N.Y.

2094. *Proposed by W. L. Warne, Alton, Illinois*

Solve the system

$$\sqrt{x+a}-\sqrt{y-a}=\frac{5\sqrt{a}}{2},$$

$$\sqrt{x-a}+\sqrt{y+a}=\frac{3\sqrt{a}}{2}.$$

Solution by Felix John, Ammendale, Md.

1. Square the given equations and subtract, with the result:

$$\sqrt{(x+a)(y-a)}+\sqrt{(x-a)(y+a)}=-2a.$$

2. This is impossible using principal roots; therefore the two equations do not form a system.

Note: If one attempts to obtain solutions, y will equal $17a/8$ and x, $a/8(51+30\sqrt{2})$; but these are extraneous roots and do not check.

Similar conclusions were reached by Alan Wayne, Flushing, L.I., N.Y.; Wm. A. Richards, Riverside, Ill.; Max Beberman, Norma Sleight and C. W. Trigg.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

2092. *Harold Davis, Portage, Ohio.*

2089, 90, 1, 2, 3. *Alan Goldman, Brooklyn, N.Y.*

2091. *Bob Cowen and Arthur Brownell, Arlington Heights, Ill.; Georgia Kapellas, Richard Schubert, Lido Brunetlin, Richard Nejdl and Anna M. Hefner, Cicero, Ill.*

2085. *Richard Schubert, Cicero, Ill.*

PROBLEMS FOR SOLUTION

2107. *Proposed by Laura J. Amer, Pontiac, Mich.*

Without actually expanding solve:

$$(12x-1)(6x-1)(4x-1)(3x-1)=5.$$

2108. *Proposed by Felix John, Ammendale, Md.*

A 30-60-90 degree triangle has the same perimeter as an isosceles triangle whose vertex angle is 120°. Find the ratio of their areas.

2109. *Proposed by V. C. Bailey, Evansville, Ind.*

Evaluation the expression: $L_{x\to 0}(\sin x)^{1/x}$.

2110. *Proposed by Harriet Rathburn, East Springfield, N. Y.*

Solve the system

$$\frac{1}{x^3}+x^2y=\frac{486}{27},$$
$$\frac{1}{y^3}+xy^2=\frac{87}{8}.$$

2111. *Proposed by Gerald Sabin, Tampa, Okla.*

A uniform bar 5 ft. long and weighing 20 lb is supported from the ends by two cords, one 4 ft. long, the other 3 ft. long and attached to a horizontal beam at points which are 10 ft. apart. Find the angle which the bar makes with the horizontal.

2112. *Proposed by A. R. Jones, Marion, Ohio*

Find a simple value for

$$\left[(\csc x-\sin x)(\sec x-\cos x)\right]^{2/3}\left[(\csc x-\sin x)^{2/3}+(\sec x-\cos x)^{2/3}\right].$$

BOOKS AND PAMPHLETS RECEIVED

TRIGONOMETRY FOR SECONDARY SCHOOLS, by Charles H. Butler, *Professor of Mathematics, Western Michigan College of Education, Kalamazoo, Michigan,* and F. Lynwood Wren, *Julia A. Sears Professor of Mathematics, George Peabody College for Teachers, Nashville, Tennessee.* Cloth. Pages vii+360. 14.5×22 cm. 1948. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $2.60.

READINGS IN THE PHYSICAL SCIENCES, Edited by Harlow Shapley, Helen Wright, and Samuel Rapport. Cloth. Pages xiii+501. 15×23.5 cm. 1948. Appleton-Century-Crofts, Inc., 35 West 32nd Street, New York 1, N. Y. Price $3.00.

THE STORY OF SOUND, by James Geralton, *Instructor of Physics at Harvard University.* Cloth. 74 pages. 13.5×20 cm. 1948. Harcourt Brace and Company, 383 Madison Avenue, New York 17, N. Y. Price $2.00.

EVERYDAY MIRACLE, by Gustav Eckstein, *Associate Professor of Physiology in the College of Medicine of the University of Cincinnati.* Cloth. Pages xi+235. 13.5×20 cm. 1948. Harper and Brothers, 49 East 33rd Street, New York 16, N. Y. Price $2.75.

THE METRIC SYSTEM OF WEIGHTS AND MEASURES. The National Council of Teachers of Mathematics: Twentieth Yearbook, Compiled by the Committee on the Metric System, J. T. Johnson, Chairman. Cloth. Pages xiv+303. 14.5×23 cm. 1948. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $3.00.

AN INTRODUCTORY COURSE IN COLLEGE PHYSICS, by Newton Henry Black, *Assistant Professor Emeritus of Physics, Harvard University.* Third Edition. Cloth. Pages xiv+800. 13.5×21.5 cm. 1948. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $5.00.

ATOMIC ENERGY, being the Norman Wait Harris Lectures, Delivered at Northwestern University by Karl K. Darrow, Ph.D., *Bell Telephone Laboratories.* Cloth. 80 pages. 13.5×21 cm. 1948. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $2.00.

RINGS AND IDEALS, by Neal H. McCoy, *Professor of Mathematics, Smith College.* Cloth. Pages xii+216. 12×19 cm. 1948. The Mathematical Association of America, University of Buffalo, 14, N. Y.

IDEAS, MEN AND THINGS. An address by J. O. Perrine, *Assistant Vice President, American Telephone and Telegraph Company.* Presented at the Seventh Annual "Science for Everyone" Congress, Hartwick College, Oneonta, N. Y. May 1, 1948. Paper. 22 pages. 15×23 cm.

HANDBOOK FOR THE AUDIO-VISUAL PROGRAM. Paper. Pages iv+41. 17×22.5 cm. 1948. Published by Audio-Visual Center, Indiana University, Bloomington, Indiana in Cooperation with Indiana State Department of Education. Price $1.00.

1948 REPORT OF THE PROFESSIONAL ETHICS COMMITTEE. 80 pages. 15×23 cm. National Educational Association Headquarters Office, 1201 Sixteenth Street, N. W., Washington 6, D. C.

RINEHART MATHEMATICAL TABLES, Compiled by Harold D. Larsen, *Professor of Mathematics, Albion College.* Cloth. Pages viii+264. 13.5×21 cm. 1948. Rinehart and Company, Inc., 232 Madison Avenue, New York 16, N. Y. Price $1.50.

LET'S LOOK INSIDE YOUR HOUSE. A Picture-Science Book About Water, Heat and Electricity, by Herman and Nina Schneider. Cardboard. 40 pages. 20.5×25 cm. 1948. William R. Scott, Inc., 513 Avenue of the Americas, New York 11, N. Y. Price $1.50.

BASIC MATHEMATICS FOR RADIO, by George F. Maedel, E.E. Cloth. Pages viii +339. 15×23 cm. 1948. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $4.75.

HANDBOOK OF ELEMENTARY TECHNICAL MATHEMATICS, by John W. Greenwood, B.S., *Professional Engineer, Lecturer in Engineering, University of Buffalo,* and M. Irving Chriswell, Ed.D., *Instructor, Buffalo Technical High School.* Cloth. Pages vi+186. 13.5×20.5 cm. 1948. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $2.10.

VISUAL TEACHING AIDS FOR HIGH SCHOOL PHYSICS, by E. DeAlton Partridge, Ph.D., *Visual Education Consultants, Inc., New York, N. Y., and Dean of Instruction, State Teachers College, Montclair, New Jersey.* A Teachers' Manual to Accompany Physics by W. G. Whitman and A. P. Peck. Paper. 48 pages. 13×20.5 cm. 1948. American Book Company, 88 Lexington Avenue, New York 16, N. Y. Price 60 cents.

INDIVIDUAL LABORATORY LESSONS IN BIOLOGY, Prepared by a Committee of the New York Association to Chairmen of Biological Sciences, and the New York Association of Teachers of Biological Sciences. Paper. 63 pages. 13.5×20 cm. 1948. George J. Davidson, *Erasmus Hall High School*, 911 Flatbush Avenue, Brooklyn 26, N. Y. Price 60 cents.

TELEVISION AND F-M RECEIVER SERVICING, by Milton S. Kiver. Paper. Pages iv+212. 21×28 cm. 1948. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, 3, N. Y. Price $2.95.

PROPERTIES AND NUMERICAL RELATIONSHIPS OF THE COMMON ELEMENTS AND COMPOUNDS, by J. E. Belcher and J. C. Colbert, *Professors of Chemistry, University of Oklahoma.* Fourth Edition. Paper. 20×28 cm. 1948. Appleton-Century-Crofts, Inc., 35 West 32nd Street, New York 1, N. Y. Price $3.00.

TELEVISION: HOW IT WORKS, by John F. Rider. Paper. 203 pages. 20.5×28 cm. 1948. John F. Rider, Publisher, Inc., 404 Fourth Avenue, New York 16, N. Y. Price $2.70.

EXTENDED SCHOOL SERVICES THROUGH THE ALL-DAY NEIGHBORHOOD SCHOOLS. Curriculum Bulletin, 1947–48 Series. Number 3. Pages vii+86. 15.×23 cm. Board of Education of the City of New York, 110 Livingston Street, Brooklyn 2, N. Y.

ANNUAL REPORT OF THE FEDERAL SECURITY AGENCY. SECTION TWO. U. S. Office of Education. Pages vii+79. 14.5×23.5 cm. Fiscal Year 1947. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 20 cents.

THE CHALLENGE OF ATOMIC ENERGY. A RESOURCE UNIT AND DISCUSSION GUIDE FOR TEACHERS AND GROUP LEADERS, by Ryland W. Crary, Hubert M. Evans, Albert Gotlieb, and Israel Light. Paper. 92 pages. 15×23 cm. 1948. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price 90 cents.

DIRECTORY OF PRIVATE BUSINESS SCHOOLS IN THE UNITED STATES. A HANDBOOK FOR VOCATIONAL ADVISORS AND GUIDANCE OFFICERS. J. S. Noffsinger, Ph.D., *Executive Secretary.* 48 pages. 14×22 cm. 1948. National Council of Business Schools, Washington 6, D. C.

HOME STUDY BLUE BOOK AND DIRECTORY OF PRIVATE HOME STUDY SCHOOLS AND COURSES, APPROVED BY THE NATIONAL HOME STUDY COUNCIL. Compiled by J. S. Noffsinger, Ph.D., *Director National Home Study Council.* Twelfth Edition. Paper. 31 pages. 13.5×20 cm. 1948. National Home Study Council, Washington 6, D. C.

APPROVED TECHNICAL INSTITUTES, Compiled by J. S. Noffsinger, Ph.D. A Handbook of Information for Vocational Guidance, Officers, Student Advisors, Etc. Paper. 48 pages 15×23 cm. 1948. National Council of Technical Schools, Washington 6, D. C. Price 25 cents.

A REPORT TO EDUCATORS ON TEACHING FILMS SURVEY, Conducted by Harcourt, Brace and Company, Harper and Brothers, Henry Holt and Company, Houghton Mifflin Company, The Macmillan Company, Scholastic Magazines,

and Scott, Foresman and Company. Paper. Pages viii+117. 15.5×23.5 cm. 1948. Harper and Brothers, 49 East 33rd Street, New York 16, N. Y.

THE ROCKEFELLER FOUNDATION. A REVIEW FOR 1947, by Raymond B. Fosdick, *President of the Foundation.* Paper. 64 pages. 15×23 cm. 49 West 49th Street, New York, N. Y.

INSTITUTE OF INTERNATIONAL EDUCATION. Twenty-Eighth Annual Report of the Director. Paper 115 pages. 14×23 cm. 2 West 45th Street, New York 19, N. Y.

EDUCATION IN HAITI, by Mercer Cook, *Professor of Romance Languages, Howard University, Former Supervisor, English-Teaching Project in Haiti.* Bulletin 1948, No. 1. Pages v+90. 14.5×23.5 cm. Superintendent of Documents, U. S. Printing Office, Washington 25, D. C. Price 25 cents.

FREE TEACHING AIDS, Compiled by Lili Heimers, Ph.D., *Director, Teaching Aids Service of the Library, New Jersey State Teachers College, Upper Montclair, N. J.* Paper. Pages viii+53. 20.5×28 cm. No. 1, 1948. Price $1.00.

LIFE ADJUSTMENT EDUCATION FOR EVERY YOUTH, Prepared in the Division of Secondary Education, Galen Jones, *Director, and Division of Vocational Education,* Raymond W. Gregory, *Assistant Commissioner for Vocational Education.* Paper W. Gregory, *Assistant Commissioner for Vocational Education.* Paper. Pages viii+122. 20×28 cm. Federal Security Agency, Office of Education, Washington, D. C.

SUPERVISOR'S EXCHANGE: GEOGRAPHY. Volume VIII, Number 1. Paper. 43 pages. 21.5×28 cm. 1948. Research Service Department, Silver Burdett Company, 45 East 17th Street, New York 3, N. Y.

BAUSCH AND LOMB PHOTOMICROGRAPHIC EQUIPMENT, MODEL L. CATALOG E-210. 20 pages. 21.5×28 cm. Bausch and Lomb Optical Company, Rochester 2, N. Y.

BOOK REVIEWS

PHYSICS, A BASIC SCIENCE, by Elmer E. Burns, *Teacher of Physics (Emeritus), Austin High School, Chicago;* Frank L. Verwiebe, *Research Physicist, Applied Physics Laboratory, The Johns Hopkins University;* and Herbert C. Hazel, *Formerly Head of Science Department, Bloomington, Indiana, High School.* Second Edition. Cloth. Pages xii+674. 15×23 cm. 1948. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $2.88.

The material of the original text was so well selected and written that a revision seems quite unnecessary. But a few important changes have been made. These consist of the addition of one or two new problems to each list, the replacement of a drawing or picture, which had little value, by recent developments in subject matter. Pages 68–73 have been changed, giving a much improved discussion of the weather. A topic discussing Radar replaces a picture of a cathode ray oscilloscope and of the electron microscope. A new short chapter on "Atomic Energy" and an 8-page appendix of physical constants have been added.

This is one of the best high school physics texts obtainable, fully equipped with questions and problems, thus making the work effective without overloading either teacher or student. All three authors have been excellent teachers for many years and by this means have extended the range of their teaching in both distance and time.

G. W. W.

TELEVISION: HOW IT WORKS, by John F. Rider and others. Paper. 203 pages. 20.5+28 cm. 1948. John F. Rider, Publisher, Inc., 404 Fourth Avenue, New York 16, N. Y. Price $2.70.

This book is designed to give students a good start in the study of television receivers. Students are expected to know fairly well the elementary ideas of electricity and radio, and to have some knowledge of sound and light. The material is grouped into twelve chapters, which were written by four men. William Bouie is the author of Chap. 1, General Aspects of the Television System, and Chap. 10, The Picture Tube. He also is coauthor with Henry Chanes of Chap 12, Alignment and Servicing. Seymour D. Uslon is the author of Chap. 2, Frequency Characteristics of the Television System, Chap. 3, Television Receiving Antennas, Chap. 5, The F-M Sound Channel, and Chap. 6, The Video I-F and Detector Section. Henry Chanes wrote Chap. 4, R-F Amplifier, Oscillator, and Mixer Circuits, Chap. 7, Video Amplifiers and D-C Restorers, Chap. 11, Power Supplies, and is the second member of the team on Alignment and Servicing. Chap. 8, Synchronizing Circuits, and Chap. 9, Sweep Circuits, were written by Richard Koch. It is expected that theory and practice will be developed together. Use of the book, as with other similar subjects, may be taken up alone or with a class, but as with other practical subjects based so firmly on the principles of science, progress is fundamentally dependent upon the individual and his effort.

The many diagrams, pictures, and graphs are well made and amply labeled. The language is clear and precise. The book will go far in aiding in a mastery of the subject, but so small a text cannot give all the practical man needs to know.

G. W. W.

A MODERN COURSE IN TRIGONOMETRY, by Alfred Hooper, *formerly Headmaster of Hillstone Preparatory School, Malvern, England,* and Alice L. Griswold, *Garden City High School, New York.* Cloth. Pages xiii+300+101. 13.5×21 cm. 1948. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y. Price $2.52.

This textbook in trigonometry is divided into four principle sections, one, plane trigonometry, two, spherical trigonometry, three, appendix, and four, tables. The first 200 pages are devoted to plane trigonometry. In this section the topics usually include in plane trigonometry are included. The explanations are somewhat lengthy and illustrations are numerous. The student will find that the explanations are thorough. The number of exercises is sufficient so that the teacher can make provision for individual differences in his classes. There are forty-four groups of exercises in this first section with emphasis being placed upon groups of review problems at the end of each of the six chapters.

The second section deals with spherical trigonometry. The three chapters of this section entitled introduction to spherical trigonometry, solution of right spherical triangles, and solution of oblique spherical triangles, provide a sufficient clue as to the range of materials in the seventy-five pages devoted to this topic.

Section III, the appendix includes certain topics which are quite often included as parts of a course in trigonometry. Some of the topics included in the appendix are: complex numbers and polar coordinates. DeMoivres theorem, inverse functions, terms used in air navigation, a summary of the trigonometric formulas studied in the book, and a discussion of approximate computation.

The last section includes tables of natural and logarithmic trigonometric functions and five place logarithms of numbers. Answers to selected problems are given in the book and a teachers manual is available which includes complete answers.

ALBERT R. MAHIN,
Broad Ripple High School,
Indianapolis, Ind.

MODERN-SCHOOL GEOMETRY, by John R. Clark, *Professor of Education, Teachers College, Columbia University;* and Rolland R. Smith, *Coördinator of Mathematics, Public Schools, Springfield, Massachusetts;* with the Coöperation of Raleigh Schorling, *Head of Department of Mathematics, The University High School, and Professor of Education, University of Michigan.* New Edition. Cloth. Pages xii+436. 13×20.5 cm. 1948. World Book Company, Yonkers-on-Hudson. New York. Price $1.88.

This is a textbook in plane geometry. The topics which are included in it are those which are usually included in Euclidean geometry, although the treatment of these topics is somewhat different than in the traditional plane geometry. There are twenty-six chapters including as chapter headings which have not always been included in plane geometry one entitled, an introduction to analytic geometry, and another entitled, concerning reasoning. There is also a section in the back of the book for maintaining basic skills and meanings.

As already pointed out the organization of this book does not follow the traditional plan of plane geometry. Formal proof of a limited number of theorems is included and geometric reasoning is emphasized throughout the book. The importance of definitions, axioms, postulates, etc. as key reasons in geometric proof is emphasized though these are used more in applying geometric reasoning to the proof of the nearly two thousand exercises included in the book than to strictly formal demonstrative proofs.

Illustrations in the book are numerous and pertinent to the subject being considered. Historical notes also are used to add interest to the study of the subject. Your reviewer felt that Modern School Geometry would probably be more attractive to high school students than many of the geometry books of past years and he is inclined to think that the principles of geometry as learned through the study of this book would prepare the student either for further work in geometry or to make a practical use of geometry in the many life situations to which it applies.

Those who feel that the primary purpose of geometry is to enable the student to make formal demonstrative proofs will probably be disappointed with this text, but those who feel that the primary purpose of geometry is to develop logical proofs and a logical method of reasoning should enjoy examining and using this book.

ALBERT R. MAHIN

CHEMISTRY AT WORK, Revised Edition, by William McPherson and William Edwards, *both Professors of Chemistry in the Ohio State University,* and George Winegar Fowler, *Supervisor of Science, City Schools, Syracuse, New York.* Cloth. Pages x+676. 15×22 cm. 1948. Ginn and Company, Chicago, Illinois. Price $2.88.

The revised edition of this excellent text abounds in diagrams and illustrations, which is a distinct improvement over the other editions.

The text is composed of two unique introductory chapters entitled "When There Was No Chemistry" and "The Great Promise of Chemistry." These chapters provide an orientation to the study of chemistry. The balance of the book is composed of thirteen units organized into logical areas of study. Each chapter is concluded by "Important Conclusions from Chapter Study," "Related Exercises and Problems," and "Questions." The teacher will find these most helpful. In addition, each unit has a list of "Unit Readings" and "Motion-Picture Films."

The text has useful appendixes which the student will find helpful in the solution of problems. The "Glossary" is based on the study by Dr. Francis D. Curtis of the technical terms used in the textbooks in chemistry for secondary schools.

Teachers of chemistry in the secondary schools of the country will find this book worthy of consideration when selecting a new text.

KENNETH E. ANDERSON

TEXTBOOK OF CHEMISTRY, Revised Edition, by Albert L. Elder, *Director of Research, Corn Products Refining Company*, Ewing C. Scott, *Associate Professor of Chemistry, Syracuse University*, and Frank A. Kanda, *Assistant Professor of Chemistry, Syracuse University*. Cloth. Pages viii+758. 16×28 cm. 1948. Harper and Brothers Publishers, New York, New York. Price $4.50.

The authors have produced a comprehensive text covering the areas of chemistry in some detail. The 758 pages are divided into 39 chapters covering the science of chemistry in the usual logical order. Each chapter has at the end, "Questions and Problems," "References," and "Articles," which the teacher will find useful in making assignments to pupils.

The text has a minimum of diagrams and illustrations, no glossary of terms, and a rather difficult vocabulary for the average high school student. There is no doubt that the text, if used wisely by the teacher, will aid in giving students a solid foundation in the essentials of chemistry. Teachers having students of better than average ability will find it worthwhile to give the text serious consideration when looking for a new adoption.

KENNETH E. ANDERSON

CHEMISTRY IN ACTION, by George M. Rawlins, *Professor of Chemistry, Austin Peay State College, Clarksville, Tennessee, and Formerly Head of the Department of Science, Public Schools of the District of Columbia, Divisions I–IX;* Alden H. Struble, *Teacher of Chemistry, Western High School, Washington, D. C.* Cloth. Pages vi+571. 16×235 cm. 1948. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $3.00.

Many war and post-war developments, and organization into a minimum number of units presented in this highly functional new text, bring the teaching of chemistry in our high schools up-to-date in content as well as in procedure and teaching psychology.

The text is generously illustrated with photographs and diagrams. The photographs are some of the best I have seen in a high school text for some time. The diagrams are unusually clear and functional. The authors have certainly treated the problem of visual aids adequately.

There are nine units with a total of forty-six problems, Problem 1 being a stimulating preview and overview of the entire book. Problem 1 answers the question "How does the use of Chemistry help to supply our basic needs?"

At the end of each problem there is a group of review questions that can be answered by the pupil, using the text. There is also another group of questions that require outside work, thus providing for individual differences. At the end of each problem is a list of books with the caption "You Will Like To Read."

One of the most useful features of the book for the busy teacher is the twenty-three pages of appendix, which contains a list of reference books, pamphlets, teaching aids, a list of useful films and where they may be obtained, a glossary of terms, useful chemical information, common names of substances and their formulas, and other vital information of use to teacher and student.

The authors have produced a text that emphasizes functional chemistry, and a detailed examination of the book indicates that it is built for both the average student as well as the more gifted.

KENNETH E. ANDERSON

MANUAL OF ASTRONOMY, A GUIDE TO OBSERVATION AND LABORATORY INTERPRETATION IN ELEMENTARY ASTRONOMY, by William Shaw, and Samuel L. Boothroyd, *Cornell University*. Third Edition. Paper. 294 pages plus several charts. 21.5×38 cm. 1947. F. S. Crofts and Company, 101 Fifth Avenue, New York 3, N. Y. Price $3.00.

This manual represents a very clear job of lithoprinting by Edwards Brothers of Ann Arbor. There are numerous, clean-cut diagrams, many tables, some

photographs, blank graph paper and data sheets for student work, and star charts. The text provides easy explanations, study questions, references, and experiment guides. In content the manual exhibits the standard coverage in an astronomy course, including such topics as: stars, planets, sun, moon, time and position, meteors, clusters, instruments, spectra, nebulae, and navigation.

Although written for the college level, the manual would be a useful reference for a high school science or mathematics teacher. For instance, Exercise 502 "Design of a Sun Dial" includes a practical discussion of the construction of a sundial, with a reference to the book *Sundials* by R. Newton and Margaret Mayall. Exercise 800 "General Properties of Lenses and Mirrors" would provide interesting material for a high school geometry class. Enrichment material for high school algebra could be obtained from the numerous graphs and tables of data. Exercise 301 "The Sunspot Cycle" contains a table of Wolf sunspot numbers from 1749 to 1936. This would permit a class in algebra to plot the data and make some generalizations about periodicity. In the opinion of the reviewer, high school science and mathematics teachers should continually brouse in such literature for possible enrichment materials. For the purpose for which the manual was written—college astronomy, the work seems to be entirely satisfactory.

SHELDON S. MYERS
University School
Ohio State University
Columbus, Ohio

SPROUTING YOUR WINGS, Prepared by Bruce H. Guild, *Iron Mountain High School, Iron Mountain, Michigan,* for the Committee on Experimental Units of the North Central Association of Colleges and Secondary Schools. Paper. Pages vii+115. 18×25.5 cm. 1947. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $1.32.

Sprouting Your Wings is written *to* as well as *for* ninth graders. The book supplies a handy, up-to-date, teachable unit on aeronautics for inclusion in the general science course or as a basis for an aeronautics club in high school. This booklet was examined carefully from the standpoint of accuracy of information, since the reviewer not only taught aeronautics at one time, but also held a pilot's license. One statement on page 25 raised an eyebrow. This was a statement that only 5–10 hours of dual flight instruction was necessary for soloing. Upon checking with the local airport, this statement proved to be correct. In fact the Civil Air Regulation on this point had been changed within the year and was now more liberal than when the reviewer had gotten his license.

The booklet contains a profuse amount of pictorial and diagrammatical material. Many cartoons illustrating important points are printed with the courtesy of the U. S. Army Air Forces, utilizing a successful pedagogical technique extensively used by the armed forces.

The treatment of the whole subject, while clearly pitched to the grade level intended, is not shallow, but penetrates to a useful and significant degree into all phases of the subject. The Appendix consists of several pages each on the following topics: Questions for Discussion and Suggested Activities, Classroom Library and Bibliography, and a List of Visual Aids.

Many times teachers are confronted with the problem of whether the inherent worth of a new unit justifies the teaching of it at the expense of existing units. If ever there was a unit with a strong basis of social need, this unit on aviation is one. In conclusion it is also clear that, with the great scarcity of aeronautical material graded to the 7th and 8th grades, this booklet fills a gap.

SHELDON S. MYERS

ANIMAL BIOLOGY, by Michael F. Guyer, *Professor of Zoology, University of Wisconsin.* Fourth Edition. Cloth. Pages xvii plus 780. 433 figures. 15.5×23.5 cm. 1948. Harper & Brothers, New York. Price $4.50.

This book continues to be one of general principles rather than details. It is designed to provide the student with fundamental concepts of the life processes rather than to burden him with specialized and unrelated bits of information.

The book is divided into six parts. Part I consists of eight chapters. The topics taken up are as follows: an over-all description of life and its interrelationships; the characteristics of protoplasm and the cell; classification and adaptations of animals: a brief description of plant life: and finally, ecology. Part II is a discussion of representative animals. An entire chapter is devoted to the conventional laboratory animal, the leopard frog. The following two chapters deal with euglena, paramecia, hydra, obelia, planaria, earthworms, crayfish, and bees. These chapters give the student an opportunity to make comparisons between animals with varying degrees of morphological, anatomical, and physiological complexity.

Part III discusses organ systems and their functions. In the first chapter of this series, skeletal systems precede integumentary systems, a reversal of the arrangement in earlier editions. The next four chapters are on digestive and respiratory systems, circulatory systems (a discussion of the Rh factor has been added here), excretory and reproductive systems, and nervous systems. Chapter XVII introduces biological aspects of human behavior, and Chapter XVIII has to do with the various types of tissue and their function.

Part IV consists of three chapters: on embryology, reproduction and fertilization, and heredity; and the six chapters of Part V have to do with evolution: its products, evidences, and theories. The final section, Part VI, is a brief survey of the entire animal kingdom and gives the characteristics of fourteen major animal phyla and their most important classes. In two, the Arthropoda and Chordata, this classification is carried down to orders, and familiar forms in each of the categories are listed and illustrated.

Throughout the text new terms are set off in bold face type so that the student can easily recognize and learn them, and at the end of each chapter there is a series of review questions. The illustrations are clear and are accompanied by adequate descriptions. This is, in short, an excellent introductory zoology text where the over-all functional approach is most desired.

GEORGE S. FICHTER

THE STATUS OF THE BEGINNING CALCULUS STUDENTS IN PRE-CALCULUS COLLEGE MATHEMATICS, A Study Carried Out with Students in Brooklyn College and City College of New York, by Mary Draper Boeker, Ph.D., *Instructor in Mathematics, Brooklyn College.* Cloth. Pages viii+83. 15.5×23 cm. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. 1947. Price $2.15.

This doctoral dissertation discusses the results of a test over the material of trigonometry, college algebra, and analytic geometry. The test was given to 131 students of Brooklyn College and City College of New York. The conclusion reached by the author, with which many teachers would agree without considering the results of this study, is that we are faced with a situation in the teaching of pre-calculus college mathematics that needs correction.

The test, consisting of 91 questions, with 125 points possible, covered ten groups of material, such as: ability to manipulate: grasp of fundamental concepts: knowledge of facts; possession of a habit of precise reading and interpretation. The various groups of questions and most of the individual questions are discussed in some detail. Perhaps one value of the study would be the possibility of comparison of weaknesses in various sections of the country. Although there might be disagreement about the inclusion of a few questions, in general there would be acceptance of the fact that most of the questions are indeed pertinent.

Teachers of pre-calculus college mathematics might well read this book carefully, with distinct value as to the need for further emphasis on the development

of certain parts of the course content. The test itself offers suggestions for question types.

CECIL B. READ

INTEGRATION IN FINITE TERMS. Liouville's Theory of Elementary Methods, by Joseph Fels Ritt, *Davies Professor of Mathematics, Columbia University*. Cloth. Pages ix+100. 14.5×22 cm. Columbia University Press, New York, 1948. Price $2.75.

This monograph gives an account of the work of J. Liouville which relates to the form which the integral of an algebraic function must have in order that the integral may be expressed with the operations of elementary mathematics, carried out a finite number of times. The question of the possibility of expressing the solution of a first order differential equation in explicit form in finite terms is discussed: likewise the possibility of expressing the solution in finite implicit terms. Among other results, it is proved that certain integrals, such as elliptic integrals, and the probability integral, are not elementary: that Chebyshev's integral is elementary only under certain conditions: that

$$\int \frac{e^x}{x}\,dx \quad \text{and} \quad \int \frac{dx}{\log x}$$

are not elementary.

Although there are several interesting historical statements, the treatment is not primarily historical. To follow the text, the reader will need command of calculus at least as far as partial differential equations; familiarity with such concepts as Riemann surfaces, analytic continuation, Taylor's and Laurent's development of a function. A statement of the author to the effect that special material of algebra or analysis is developed when needed, while true, does not mention that such development may seem very brief to one unfamiliar with the particular topic.

The book might find value as a text or supplementary text in a graduate course: it is more likely that it will be placed in many libraries as a reference. From this point of view the lack of an index is unfortunate. A twenty-three item bibliography in included, which is stated not to be complete.

CECIL B. READ

HIGHER ALGEBRA, A Sequel to Higher Algebra for Schools, by W. L. Ferrar, M.A., D.Sc., *Fellow of Hertford College, Oxford*. Cloth. Pages vii+320. 14.5 ×23 cm. Oxford, at the Clarendon Press, 1948. Price $5.00.

The author states that the book is written for young mathematicians who have already studied the more elementary parts of algebra. This reference to English students emphasizes the difference in mathematics courses in England and the United States. The book would not be a suitable text for a high school course, in fact, it is doubtful if many teachers would want to use it in junior college work. The scope of the material is indicated by chapter headings: Finite Series: Infinite Series: Complex Numbers: Difference Equations and Generating Functions: Theory of Equations: Partial Fractions: Inequalities: Continued Fractions.

Some of the treatment, although rigorous, is reasonably elementary. The teacher will find some portions a true treasure trove of hints, problems, proofs, and other usable material. For example, the reviewer has not seen elsewhere a description of a very helpful device in partial fractions, which the author calls the "cover-up rule"; material on the applications of complex numbers is particularly fruitful. Much of this material would provide excellent supplementary work for the superior student. There is a large collection of exercises, many of which are relatively simple: others are designated as more difficult. The text material itself is likewise designated as falling into one of three levels of difficulty.

The thorough treatment of the topics would make the book a valuable refer-

ence for a high school library, and particularly valuable in a college library where portions might well be made required supplementary reading in work in advanced algebra, theory of equations, or some portions of calculus.

CECIL B. READ

INTERMEDIATE ALGEBRA, by Jack R. Britton Ph.D. and L. Clifton Snively, M.S. (E.E.) *University of Colorado*. Cloth. Pages ix 337. 22×15 cm. 1947. Rinehart & Company, Inc., New York. Price $2.00.

The authors, Britton and Snively, recognize the fact that most students who elect a course in Intermediate Algebra in college have a poor background in basic mathematics. The first chapter is more than a mere "refresher" or review of the fundamentals of arithmetic basic to an understanding of algebra. It is rather a "new view" for this type of student. The last statements are equally true of the concepts of elementary algebra. The text then proceeds so that the authors suggest that the first twelve chapters give an adequate course in Intermediate Algebra and that the last three chapters are for the more advanced students. Sets of review problems are given to implement a rapid survey of the first chapters for students who do not need to start at the beginning of the book.

In chapter twelve, material from plane geometry is used for work in ratio and proportion. The concept of similar triangles is developed and used to prove the Pythagorean Theorem. The chapter continues with variation as met in the laboratory to impress the importance of this topic.

The appendix contains five place tables of common logarithms for computational work. Powers, Roots, and Reciprocals table gives values of six significant digits. Answers are listed for the odd numbered exercises.

Throughout the text important ideas and principles receive the major emphasis without neglect to techniques and manipulations. All in all it does a good job in moving from the first course in algebra to college algebra.

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ELEMENTARY CONCEPTS OF MATHEMATICS, by Burton W. Jones, *Cornell University*. Cloth. Pages xvi+294. 1947. The Macmillan Company, New York. Price $4.00.

This book is the outgrowth of a need sensed by the members of the Mathematics Department at Cornell University for a course designed for students who have had a minimum of training in the subject, who do not plan to take more courses in mathematics, but who want a firmer grounding in the subject and such additional training as they may find interesting or useful. In its original form various chapters were written by different members of the department. That material was used in classes and revised before appearing in textbook form.

The author attempts to cultivate an understanding of the material, to straighten out in the student's mind certain mathematical concepts of his everyday life which are usually only dimly understood, to cultivate an appreciation of mathematics, and to emphasize logical development. The content includes logic, the positive integers and zero, negative integers, rational and irrational numbers, algebra, graphs and averages, permutations, combinations, probability, mirror geometry, Lorentz Geometry, and Topology.

Aside from arithmetic and a little algebra and plane geometry, no previous training is assumed on the part of the student. The material is presented in an interesting fashion and in a simple manner. Each topic is followed by a set of practice exercises.

The text is designed for college students and deserves the consideration of the instructor looking for a book of this type. The material will also interest teachers of high school mathematics as well as some advanced high school pupils.

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